RAILROAD
SHOP PRACTICE

RAILROAD SHOP PRACTICE

METHODS AND TOOLS

BY

FRANK A. STANLEY

CONSULTING MECHANICAL ENGINEER; EDITORIAL REPRESENTATIVE "AMERICAN MACHINIST;" MEMBER AMERICAN SOCIETY MECHANICAL ENGINEERS; AMERICAN INSTITUTE MINING AND METALLURGICAL ENGINEERS; FRANKLIN INSTITUTE; AUTHOR, "AMERICAN MACHINISTS' HANDBOOK," "AUTOMATIC SCREW MACHINES," "ACCURATE TOOL WORK," "AMERICAN MACHINIST GRINDING BOOK," "PUNCHES AND DIES," "MACHINE SHOP PRIMER," "DRAWING ROOM PRACTICE," ETC., ETC.

FIRST EDITION

McGRAW-HILL BOOK COMPANY, INC.
NEW YORK: 370 SEVENTH AVENUE
LONDON: 6 & 8 BOUVERIE ST., E. C. 4
1921

THE MAPLE PRESS YORK PA

PREFACE

The upkeep of rolling stock in the railroad repair plants of America constitutes an industry of first importance. The hundreds of shops and round houses along the railway lines of this country employ hundreds of thousands of mechanics and the expenditure in dollars for materials and labor amounts to several hundred millions annually. Scattered about the four quarters of the United States, often in isolated localities, these shops have built up a practice in engineering and in the mechanical trades that is of inestimable value to the railway systems themselves and to many allied industries. Individual reliance and judgment have been developed to a marked degree among shop officials and workmen as a result of the necesssity for initiative and prompt action in situations where the time element is all important and where only too often shop equipment is inadequate for the work in hand.

Under the general conditions obtaining in such shops where usually locomotive and car parts are handled in comparatively small numbers at any given time, considerable ingenuity is required upon the part of individuals responsible for the machining and fitting up of the work passing through the different departments of the shop. While in some instances the shops are of such size as to make possible the methods of regular machine building plants, this is after all the exception to the rule; and in the main the railroad repair shop necessarily runs its work through in very small lots, often only a few parts at a time. Consequently the methods of the shops are apt to differ one from another and the special tools and devices for carrying on the work are oftentimes developed in the individual plant to suit its particular necessities.

A great deal is to be learned therefore by a study of operations in the different classes of railroad shops, large, medium and small, and it is the purpose of this volume to show typical methods and appliances as adapted to the work of various repair shops located at widely separated points about the country.

Much of the material presented in the following pages has been adapted from the author's articles in the *American Machinist* and other technical journals, and a limited amount of data has been included from the contributions of other writers to whom credit is given in the text. Much original matter is also here presented for the first time.

In the gathering of material for this subject every courtesy has been extended the author by the officials and shop executives of a large number of railway lines and acknowledgement is herewith made of the assistance rendered in this direction. Special thanks are due the shop staffs of the Southern Pacific, New York Central, Pennsylvania, Santa Fe, Lackawanna, New Haven, Milwaukee, Soo, Northern Pacific, Great Northern, Union Pacific, Chicago & Northwestern, Burlington, Frisco, Katy, Canadian Pacific, Oregon Short Line, and other systems.

THE AUTHOR.

CONTENTS

CHAPTER IX

CHAPTER X

CHAPTER XI

CHAPTER XII

CHAPTER XIII

CHAPTER XXII

CHAPTER XXXIII

RAILROAD SHOP PRACTICE

CHAPTER I

THE WORK OF THE RAILROAD REPAIR SHOP

Strip a big, modern locomotive of its side motion and valve gear; remove driving wheels and boxes from under the frame; open up cylinders, steam chest and boiler front; remove the cab from the end and the burnished steel casing and its underlying lagging of asbestos from the entire length of the boiler. Then drop the naked boiler and its exposed frame upon 10-in. cribbing placed across the shop pit, and you have before you the skeleton of a huge machine which under the efforts of a crew of mechanics and helpers will be overhauled, repaired and refitted until it assumes once more its spectacular appearance and, restored to its full working capacity, is again ready for service on the road.

Almost anything may happen to a locomotive in use. As a matter of fact, the things that usually do happen are due to the natural wear and tear brought about by conditions of regular service. They necessitate such shop operations as re-turning or re-tiring of wheels; the refitting of boxes, side rods, pistons and so on; the replacing of, say, boiler tubes or firebox sheet, and the repairing of a multitude of details. Most of these matters are taken care of at short notice and with little loss of time, until eventually an accumulation of necessary repair items causes the engine to be sent to the shops for a real stripping down and a general overhauling from one end to the other and inside as well as out. This, as may be imagined, is quite an undertaking.

Now, this subject of upkeep of rolling stock, including both locomotives and cars, is one of wide importance and interest, not only from an engineering angle, but also because of the magnitude of the repair industry as carried on by the railroad shops of the United States. At the time of the outbreak of the World War the railroad shop repair operations as gaged by the value of the work turned out constituted an undertaking standing as seventh in our list of great manufacturing industries. Measured by the

number of men employed, the industry ranked as fourth in order of importance.

Consider for a moment what is accomplished by the 1,200 or more railroad repair shops in this country, of which number over one-half are establishments of considerable size: At the time referred to they employed over a third of a million mechanics of various classes, these keeping in order some 65,000 locomotives and over 2,500,000 freight and passenger cars, the annual expenditure on the maintenance of this rolling stock approximating $400,000,000, a sum equivalent to that required for the construction of the Panama Canal. Expressed in another way, the upkeep of this equipment, as operated over the 250,000 miles of railway lines in the United States represented a rolling stock repair bill of practically $1,600 for every mile of track in the country.

The abnormal condition of the Nation's business as a whole during and since the war and the corresponding readjustment all along the line of industrial endeavor makes it impracticable to present at this time corresponding data covering accurately present-day conditions. The above statistics will, however, convey some fair idea of the importance of the railroad repair shop industry.

A modern locomotive is an expensive piece of machinery. In the more common types the original cost will average say $30,000 to $45,000 or more while the big articulated Mallet machines so generally operated over the far Western and Southwestern lines cost from $50,000 or so up to $75,000 or more. Engine crews carry a heavy burden of responsibility in the direction of holding to a minimum the wear and tear on the costly machines in their charge, but even under the best of operating conditions the annual repair account for the average locomotive is sufficiently high to astonish people not versed in the details of the upkeep of transportation equipment.

The development of the locomotive like that of other lines of mechanical equipment has led from simple, light units to larger and heavier machines until today we see an amazing departure from the almost elementary designs of 50 or 60 years ago. And correspondingly, the work of repairs on any given engine has become more complex as compared with the early simple constructions while, in addition, the gradually increasing number of locomotives and cars in service has necessitated an

expansion of the facilities about the country for caring for rolling stock in general.

Note, for example, the big modern Mallet 2–8–8–2 oil-burning engine in Fig. 1 and then compare it with the "C. P. Huntington" Fig. 2, both Southern Pacific locomotives, but the latter long since retired from active duty and set aside in a conspicuous position near the Sacramento station where it forms an interesting example of locomotive design of the "early sixties." Or compare the "C. P. Huntington" with "No. 2840," Fig. 3, which is one of a considerable number of heavy engines built at the Southern Pacific shops in Sacramento during the recent past. This consolidation locomotive as it appeared when ready for mounting on its wheels is shown in Fig. 4 and this excellent view in one of the biggest of our railroad shops is here supplemented by two other interior photographs, Figs. 5 and 6 representing typical erecting shop views.

Fig. 1.—Mallet locomotive, Southern Pacific Company.

In addition to the actual costs of repairs there is still another serious factor to be considered in connection with the engine-overhauling proposition and that is the attendant tying up of a valuable piece of equipment during the repair period and the consequent loss of earning power for the time the engine is in the shops. This is fully appreciated by the mechanical departments of railroad systems and it goes without saying that even under ordinary conditions of business, locomotives undergoing

repairs are, on a well-organized division, hustled out of the shops with the greatest possible despatch consistent with satisfactory workmanship. The great amount of work handled also necessitates all possible despatch in getting the engines through the shops.

FIG. 2.—A locomotive of 1864.

Engineers familiar with the progress in methods of manufacture have seen such advance in machine operations and so marked a tendency toward elimination of handwork in many directions that oftentimes they look forward to a day in the future when the old handicrafts of the shop shall have disappeared

FIG. 3.—Consolidation locomotive built at Southern Pacific Shops, Sacramento, Cal.

completely. Possibly such a day and such a condition may be marked on the calendar of the years to be; but for the present moment, if anyone whose observations in this direction have been based upon experience in certain highly organized factories

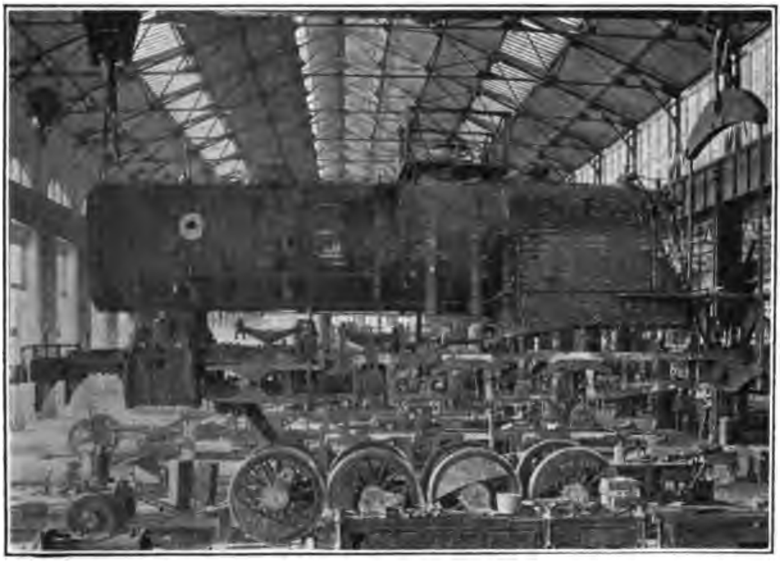


FIG. 4.—Mounting locomotive on wheels.

FIG. 5.—Engine carried bodily by crane over erecting floor.

manufacturing some small, light product will devote his attention for a brief period to the operations conducted in any typical railroad shop, he will be led to the conclusion that in these establishments at least, comparatively little diminution in various hand processes there followed is to be expected for some time to come. And this is not because there has not been marked and regular progress in the general methods of such repair shops, but because of the peculiar character of the work therein handled, which necessitates the retention of many of the fundamental processes of the metal working plant in which skill of hand and

Fig. 6.—Locomotive erecting department Southern Pacific Shops, Sacramento.

brawn of arm are quite as essential as in the day when machine tools were largely unknown.

Let the visitor pass through the machine departments of the railroad shop and he will find in many instances the specialized methods of the manufacturing plant. He will see wheels and axles dismounted, new wheels and axles machined and assembled under the time-saving system of a well-conducted factory. He will see boxes poured, bored and faced, shoes and wedges planed, and other parts which are required in quantities machined in the methodical manner that would be characteristic of any up-to-date shop manufacturing similar parts as a specialty. And he will

find modern equipment in the line of wheel lathes, turret machines, boring mills, grinders, radial drills and the like.

Now let him cross over to the erecting floor and observe the character of the work to be done on the locomotives over the pits. Examine for instance, the engine shown in Fig. 7. Stripped to the very bones, obviously a tremendous amount of hand labor is required in refitting and putting the engine into working condition. To be sure, the crew of machinists, boilermakers and helpers who do this work make extensive use of pneumatic drills, air hammers, chisels and riveters, and there has been marked advance in the substitution of such tools for the

FIG. 7.—Overhauling a big engine.

simpler appliances of earlier times; but, after all, these are virtually hand tools depending for results upon the personal skill of the workmen, who must still hold the tools to the work and guide them properly for drilling and chipping cuts and for riveting blows. Moreover, many of the operations required in the overhauling process are of such nature, or are performed upon such part of the engine, as to render impossible the application of any tools other than the time-honored simple appliances swung or rotated by the human hand and arm.

And still, on the other hand, there are various important operations on engines on the floor, which are now taken care of by mechanical devices, in most cases developed by individual

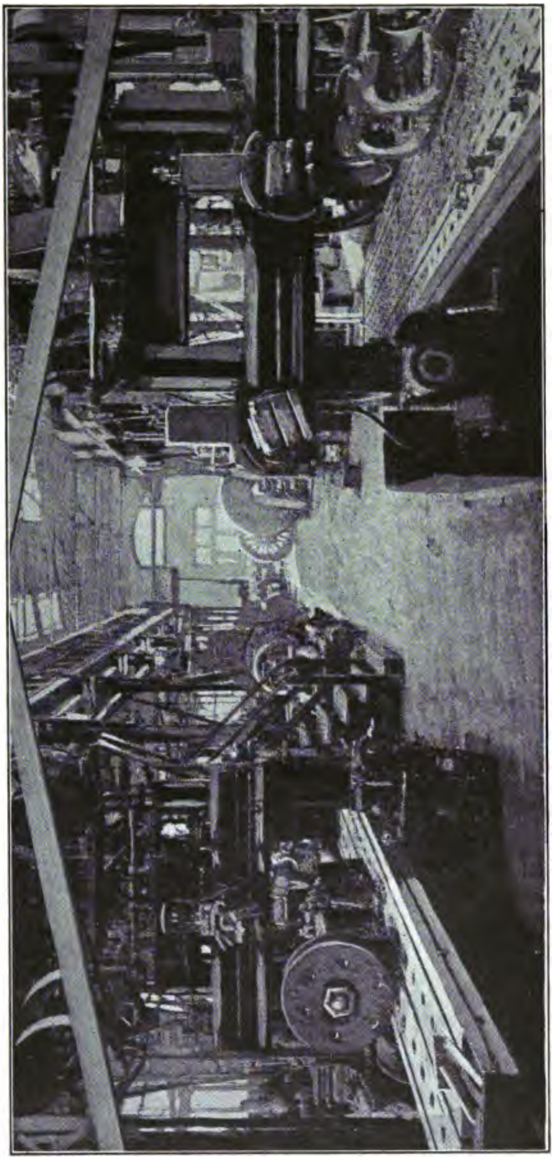


FIG. 8.—Machine department in railroad shop.

shops for their own use and found to be valuable time and labor savers. These appliances are usually for some special purpose only; and while facilitating greatly the accomplishment of the work for which they are constructed, they cover only a small part of the total work involved in the overhauling of a locomotive. It is in respect to these very appliances that the methods of one railroad shop often differ widely from those of another doing similar work, and frequently these special devices are a fairly accurate measure of the degree of ingenuity developed by executives and workmen in the different departments of a given plant.

Referring now briefly to typical machine departments, Figs. 8 and 9 are general views in a well-known railroad division shop, that of the Southern Pacific Company at Sparks, Nev. The department view, Fig. 8, shows in the foreground two planing operations which will be referred to in detail in another chapter. The planer at the left is illustrated in operation on a crosshead attached to its piston rod and supported on the platen of the machine by a pair of angle irons provided at the top with suitable V-seats and clamps by which the piston rod is located parallel with the platen and held securely while the guide bearing surfaces are planed out in the crosshead. The planer at the right of the aisle is shown with a pair of driver boxes in position for the planing of the bearing surfaces along their edges.

The illustration in Fig. 9 shows the arrangement of some of the medium-sized tools and the method of lighting, etc. A variety of work handled in this department is illustrated in later chapters.

SOME SPECIAL APPARATUS

A number of special appliances of the kind referred to in preceding paragraphs are here illustrated as devised and used at the Sparks shops. Referring again to Fig. 7, there is of course nothing novel in the portable machine shown in the operation of reboring the steam chest for the piston-valve cage, but this view does illustrate the method of applying the boring outfit while simultaneously a multitude of other things are being done toward putting the engine into shape and getting it ready for wheeling.

At the extreme left will be noticed a portable oil forge or rivet heater. Near the middle of the boiler will be seen several lengths

FIG. 9.—Another view in machine department.

of air hose which are carried across under the frame to operate pneumatic tools at the far side of the engine. The portable forge

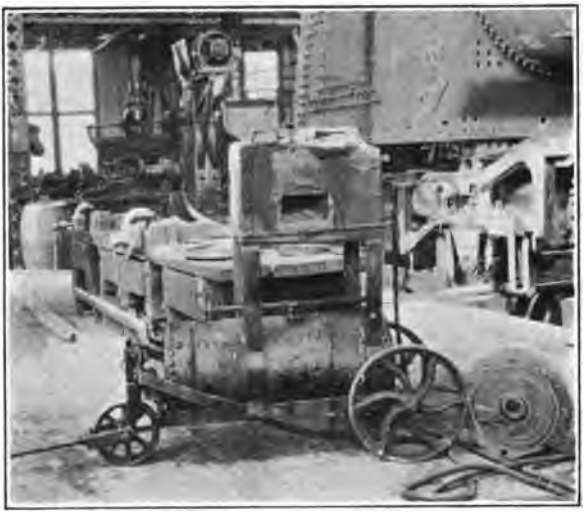


Fig. 10.—Portable oil forge and heater.

and rivet heater is shown clearly in Fig. 10. It is one of a number of similar pieces of heating apparatus used in various departments of the plant. It carries on a three-wheel truck a fuel oil

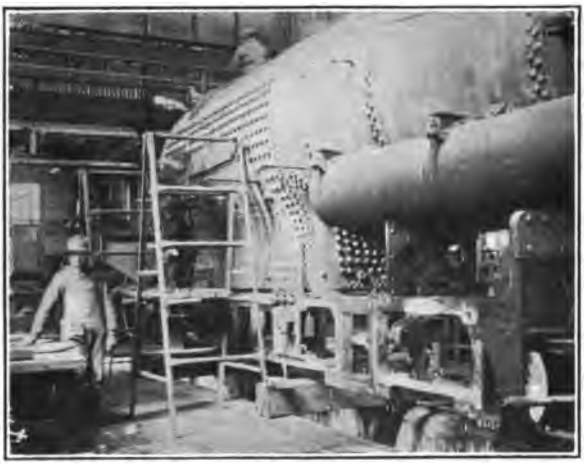


Fig. 11.—Shop trestle made of old boiler tubes.

tank with a capacity of about 30 gal. and from the truck sides rise a set of standards for supporting the forge proper. The

pipe connections for carrying the oil fuel to the heating chamber are shown at the top of the supply tank, and the air pipe will be seen at the right. The air connections are made by hose to any service pipe in the department.

FIG. 12.—Engine ready for wheeling.

A very dependable and convenient form of shop trestle for holding work platforms and enabling the men to stand at any desired height along the engine is illustrated in Fig. 11. The structure is of steel throughout and is in fact constructed entirely of old boiler tubes. The tube lengths for the uprights of the trestle are first swaged along one side to flatten and force the

FIG. 13.—Pumping outfit for boiler test.

tube inward for nearly one-half its diameter so that a section through the reformed tube would resemble a crescent. This treatment stiffens the member and at the same time forms a convenient shape for the riveting on of the shorter crosswise

lengths of tube which tie the uprights together in "A" form and provide steps for supporting the planks or scaffold for the workmen. Another one of these arrangements will be noticed beside the firebox of the engine in Fig. 12, the locomotive here shown being almost ready for the replacing of the driver boxes and wheels; ready for wheeling, as the shop expression goes. Immediately in front of the trestle and to the left is another handy appliance, a portable outfit for testing boilers.

FIG. 14.—Wheeling a locomotive.

This outfit is represented more clearly in Fig. 13, which shows the apparatus itself as mounted upon a small truck and also the pipe and hose connections from air and water supply and to the boiler. The pump proper is an old air pump, the cylinder of which is bolted securely to base blocks across the truck body and to upright braces, as indicated in the photograph. The boiler ready for testing is filled with water, and steam is then turned

on through the pipe connection to heat the water. Then the air pump is set in operation for pumping up the pressure in the boiler.

The photograph, Fig. 14, illustrates the wheeling of this same locomotive. In the view, the engine has been picked up bodily by the big overhead crane, the heavy slings for the purpose being hung from the two hooks of the double crane hoists and passed under front and rear ends of the locomotive, although only the sling for the rear end of the frame is visible in the photograph. The four pairs of driving wheels and axles have been rolled into position under the engine and blocked in correct position on the

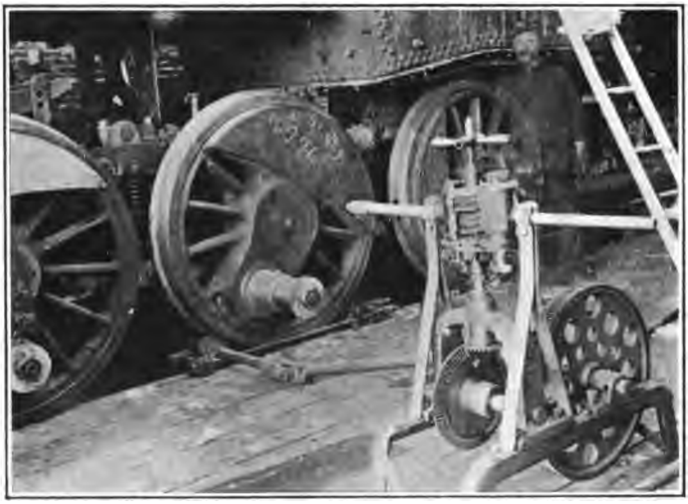


Fig. 15.—Wheel rotating outfit used when setting valves.

track. The driver boxes have been placed upon the axle journals, so that when the locomotive is lowered by the crane, the boxes will enter the corresponding jaw openings in the frame.

The machine in Fig. 15 is another home-made device of the kind that helps along the work over the pits. It is used when operations on the locomotive have progressed to a point where valves are to be set and consequently a pair of driving wheels must be turned over. The rollers, placed under the wheels as shown, are adjusted by nuts on the bolts through the brackets.

The cross shaft and toothed rolls are actuated through universal joints by means of a gear-driven shaft on the machine

proper. This shaft is connected by spur and bevel gears with an air drill held in vertical position at the top of the outfit.

The foregoing particulars about some of the appliances of this shop have been given as features of interest in connection with this first chapter on some of the diversified special devices that come into service in railroad shops. Various other special items of equipment are illustrated in later chapters along with many methods of machining and fitting engine parts.

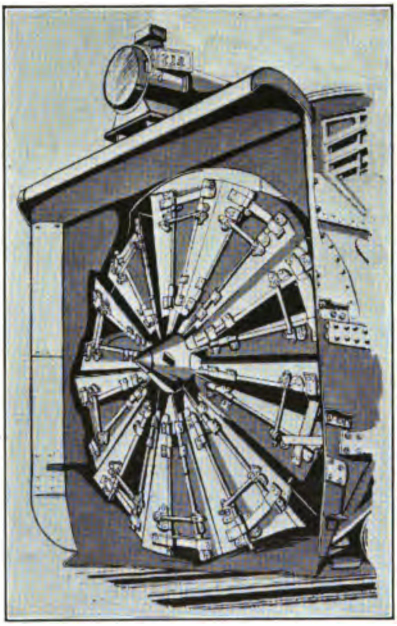


FIG. 16.—Rotary snow plow.

One interesting piece of railroad equipment taken care of at this point is the rotary snowplow, Fig. 16. Despite the many miles of snow sheds over the Sierras, blockades do occur now and then in the midwinter season, and the clearing of tracks then constitutes a serious problem. The rotary plows used of the type illustrated in Fig. 16 have a 12-ft. wheel with 10 sets of blades that measure at the outer ends about 18 in. in width and have a length of 5 ft. These blades or vanes, are adjusted at the shops to a uniform lead or pitch and normally are set for a lead of approximately 2 in.

In connection with the foregoing reference to occasional wintry weather in the above vicinity an interesting feature is the system of rolling steel doors, Figs. 17 and 18, for closing the entire length of the big roundhouse. The views show these doors open and

FIG. 17.—Rolling doors, open.

FIG. 18.—Rolling doors, closed.

closed and show the method of operating with hand chain and gearing so that any door may be rolled up to clear the corresponding track for an engine passing in or out and then as readily dropped to close the passageway completely.

CHAPTER II

OPERATIONS ON LOCOMOTIVE CYLINDERS

The machining of a locomotive cylinder involves the application of a number of operations, including boring the cylinder proper; boring the valve chamber if piston valves are used, or planing the steam chest and valve-seat surface if of slide valve type; facing the ends for the heads, planing the joint surfaces for saddle,

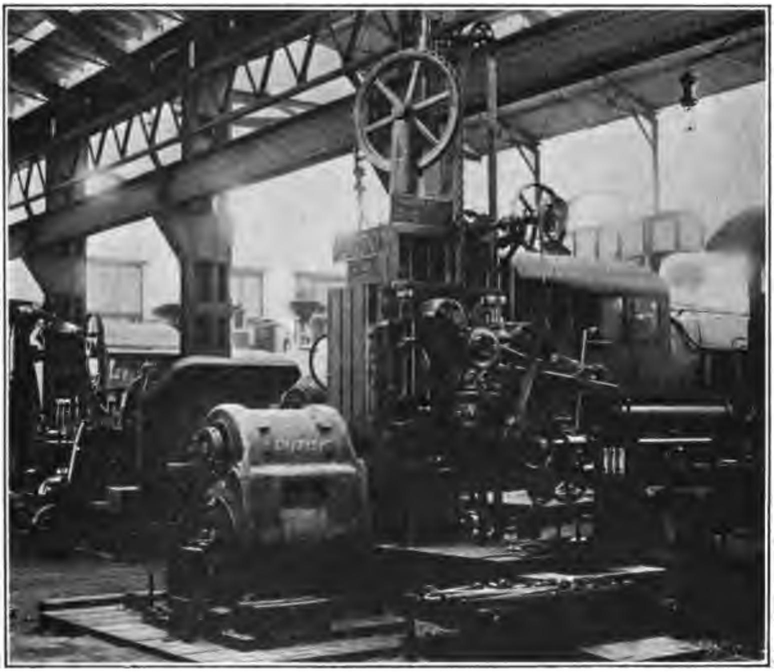


FIG. 19.—Boring valve chamber in cylinder, Southern Pacific Shops, Sacramento, using big draw-cut machine.

etc.; drilling for stud holes and so on. With big cylinders particularly it is the practice in many shops to use the draw cut shaper for the boring of cylinder and piston valve chamber as well as for the planing of saddle and other surfaces. An illustra-

tion of a boring operation on a machine of this type is presented in Fig. 19.

In this instance the regular piston bore has been completed and the work is shown set up for the boring of the valve chamber. For the operation the casting is mounted upon a trunnion carrier where it is located upon the cylinder bore and is here set in correct position in respect to the vertical face of the cylinder

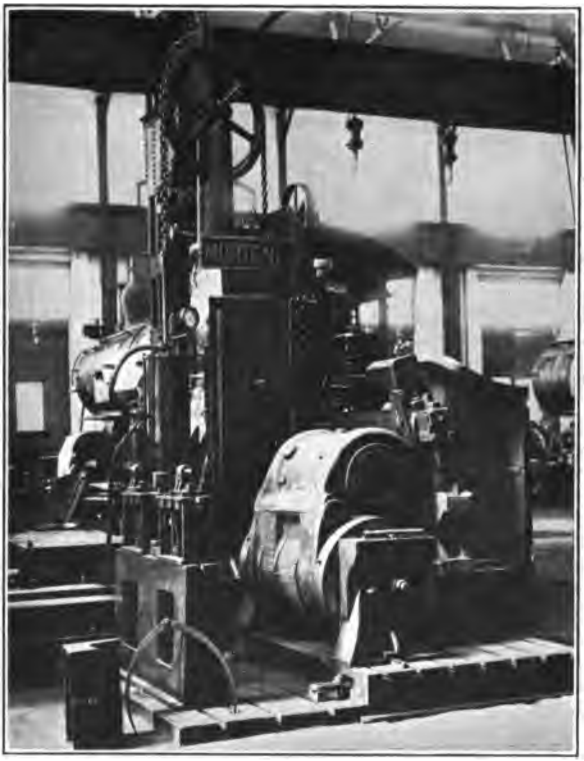


FIG. 20.—Planing a deep seat on the cylinder casting using draw-cut machine.

casting. The boring is accomplished by means of a multiple-tooth boring head mounted upon a spindle which is carried in the regular ram of the shaper. For the purpose of boring, this ram is arranged to be disconnected from its regular reciprocating motion and given a slow traversing motion suitable for boring at the desired rate of feed. The draw-cut shaper is thus adapted for the work of a horizontal boring machine. It

may also be used as a milling machine by applying a milling cutter to the spindle of the ram, the mechanism being arranged

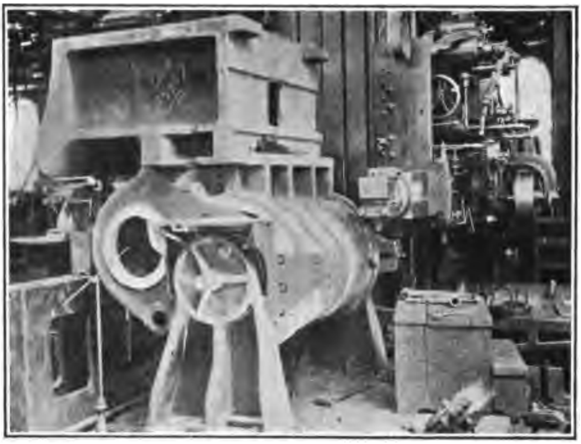


FIG. 21.—Set up for planing side of casting.

for giving required feeding movements for the column and head as well as for the end positions of the cutter spindle and mill.

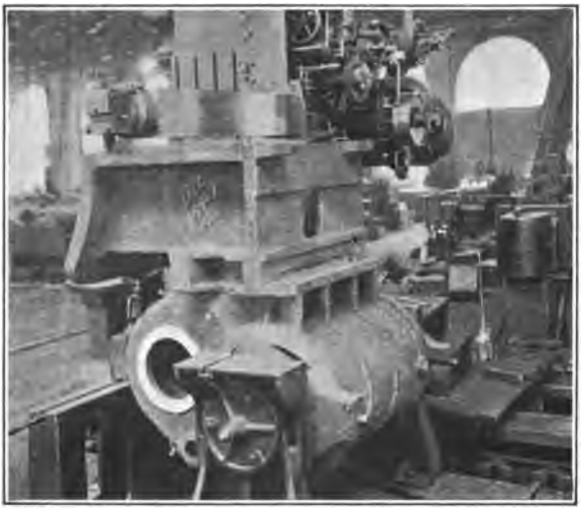


FIG. 22.—Planing joint face of cylinder.

The long stroke of the ram with its draw cut action adapts the machine to the satisfactory accomplishment of various awkward

operations. Such for instance is the operation seen in Fig. 20. Here the ram head is shown with a long projecting planing tool reaching down between the steam chest proper and the adjoining saddle wall to operate on the frame-bearing seats at this point. For this operation the work is still mounted upon the trunnion fixture so that the planed surfaces will be parallel to the cylinder bore.

In Fig. 21 the cylinder is shown swung up to position for planing the frame-bearing surfaces at the under side of the casting, and in Fig. 22 with the work in the same position the operation

Fig. 23.—Cylinder on floor for laying-out.

of planing the vertical inner face is represented, the surface to be machined being here located in horizontal position.

A similar design of cylinder on the floor ready for general laying out is shown in Fig. 23. Here two centering sticks are shown in the bore of cylinder and valve chamber and with the casting levelled up by means of the jacks under the inner corners, various centers for studs and bolts and other center lines and locating points are obtained. Such castings are rather intricate pieces of work from the point of view of both pattern maker and machinist. This will be seen upon examination of the drawing, Fig. 24 which is here reproduced to illustrate some of the work required in putting such castings through the shop.

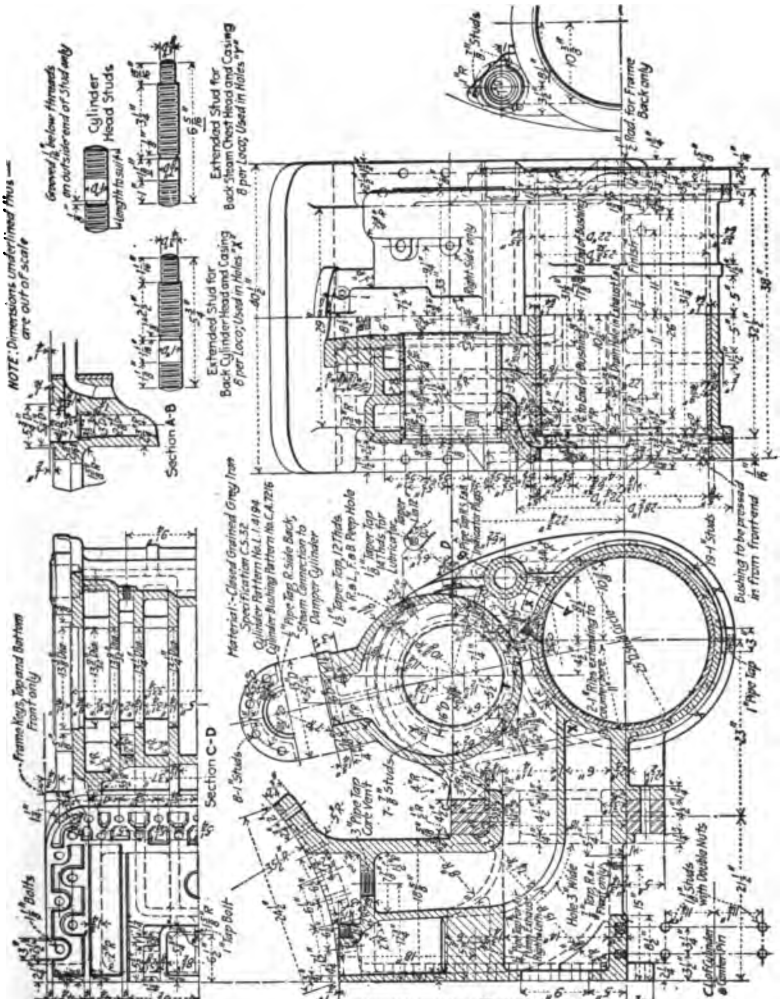


FIG. 24.—Details of a locomotive cylinder.

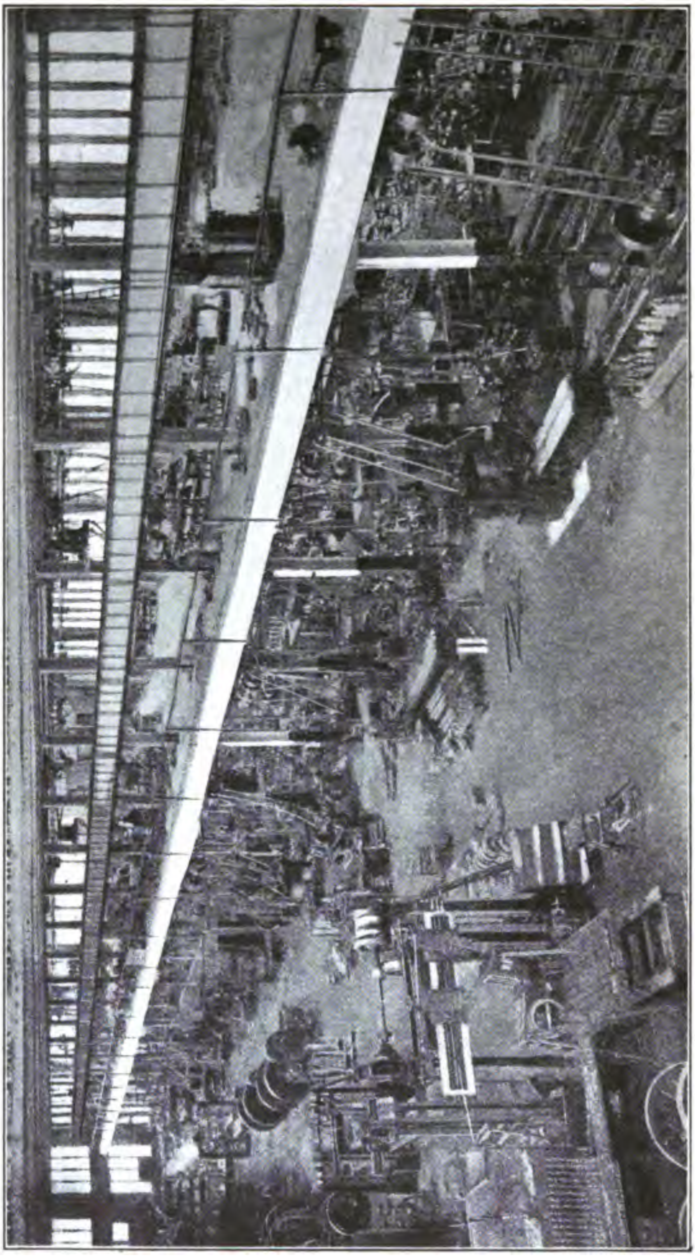


Fig. 25.—The Frisco shops at Springfield, Missouri.

PLANING THE SADDLE RADIUS

The planing of the radius of the top of the saddle of a cylinder of this type is often times accomplished with the work set up on the planer in the manner represented in Figs. 25 and 26, the latter view showing a big planer which in Fig. 25 is seen at the left of the aisle and in the foreground of the photograph. In Fig. 26 it will be observed that the planer tool is carried at the end of a heavy holder where it is adjusted to the desired radius

Fig. 26.—Radius planing attachment for locomotive cylinder.

as measured from the center of the swivel on the planer head. The saddle carrying this head is clamped to the crossrail at the proper point in relation to the cylinder casting, the swivel bolts are eased enough to allow the head to swing, and the upper end of the slide is connected by a rod or link to the left-hand planer head. When the crossfeed is applied to traverse the latter head along the rail, the right-hand head is of course swung about its

swivel center and the top of the cylinder casting is thus planed out to an arc of the required radius.

This constitutes a very interesting planing undertaking; the half-saddle form of casting is anything but easy to block up and set properly for the work must be positioned to bring the center joint in correct relation to the arc which is to be planed out to carry the front end of the boiler, and as the casting is of considerable height it has to be well braced against the action of the cut. For this reason a strut is placed against the upper inner corner under the flange and abutted firmly against a stop in the planer table slot. Two jacks are used under the bottom of the inner face of the casting to carry the overhanging saddle portion and these are adjusted to swing the work up to the desired position. The size of this cylinder casting requires the full capacity of the planer as regards clearance under crossrail.

PLANING SEVERAL CYLINDERS AT ONE SETTING

Where the cylinder castings are put through the shop several at a time it is possible to plane a number of them in a string on the platen. The work is set up on the planer and the cut taken from end to end. This is not feasible with all designs of cylinders, and then too, the work is usually passed through the smaller shops a cylinder or two at a time making it impracticable to do otherwise than handle each cylinder as a separate job. But in the larger shops with various duplicate parts going through at once such operations as string planing, gang milling and other group undertakings are carried out to advantage.

The advantages in economy of time, uniformity of work in respect to dimensions and finish, and convenience in setting up will be appreciated by mechanics. The total end thrust can be taken by the outer or end casting and the strapping and clamping of the other cylinders is correspondingly simplified.

SIMPLE DRILLING JIGS

Usually such jigs as are employed for drilling cylinders for stud holes are of simple character, composed of a ring in which guide bushings are placed at the required distance apart in a circle of the specified diameter. An illustration is presented in Fig. 27. The jig ring is 7/8 in. thick and in this instance the outside diameter is 29 1/4 in. There are 20 tool-steel bushings

equi-spaced about a 26-in. circle and these are made for a $^{55}\!/_{64}$ tap drill. The jig is provided with four locating points in the form of stops which are fastened in seats cut into the interior of the ring and these stops are turned off on their outer diameter to the cylinder counterbore size so that they serve to locate the jig accurately with the bore of the cylinder.

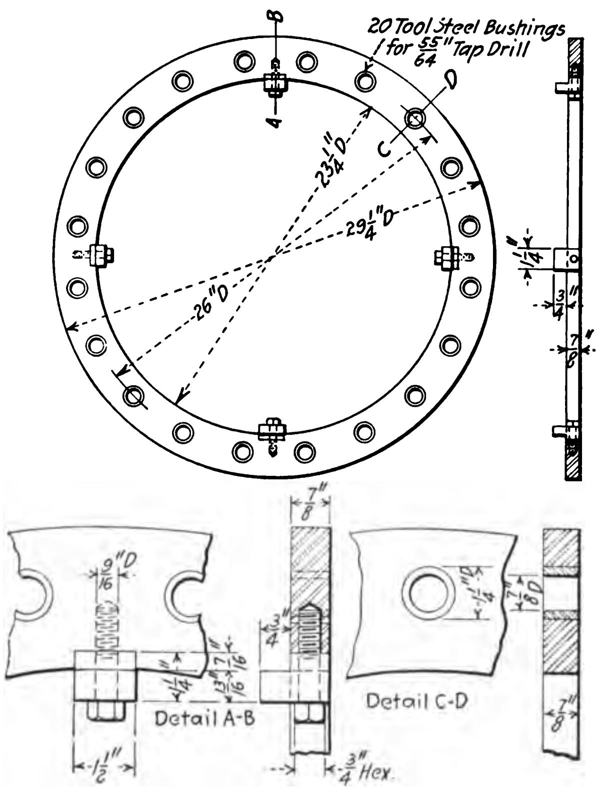


Fig. 27.

MILLING PORTS

The milling of cylinder ports can be attended to in various ways. Sometimes a horizontal boring machine is used for this operation. The casting is placed on the work table with the cylinder bore in vertical position so as to bring the edges of the ports horizontal or parallel to the table. Suitable supports and clamps are applied for locating and securing the cylinder properly and a small mill is then used in the regular spindle for machining

out the port openings. The feed movement of the table and the head adjustments allow the work to be readily milled for correct port opening and the next cuts to be taken successively by simple movement of the mill up or down to give the correct spacing for the location of the next port.

PORTABLE APPARATUS

A portable boring outfit for cylinders is shown in Fig. 28. The boring bar is mounted in bearings which are hung from brackets

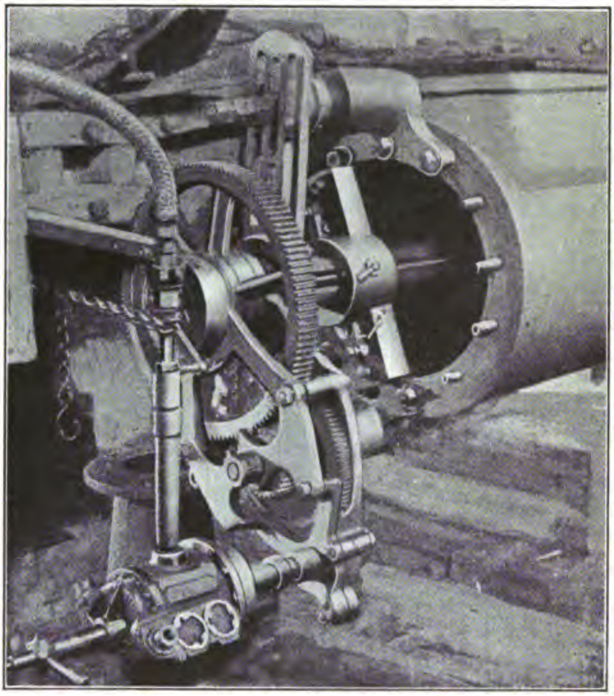


Fig. 28.—Portable boring bar for cylinders.

secured to the cylinder studs in the manner illustrated. The driving motion for the bar is transmitted from the air motor through the medium of a spur gear train to give the requisite speed reduction for the boring head. The feed for the head is by means of screw and star feed.

A portable boring bar is used at the Union Pacific shops at Omaha, Neb., with an electric motor and controller carried on a

substantial steel truck which enables the outfit to be hauled to any part of the shop where it may be required A short horizontal shaft at the front of the truck is driven at relatively slow speed through reduction gearing from the motor shaft, and this hort shaft is connected with the gearing on the portable boring bar by means of a telescopic shaft fitted with universal joints so that the height of the cylinder above the motor truck does not in any way affect the operation of the device.

CYLINDER WORK ON THE ENGINE LATHE

The use of the lathe as a boring machine is considered a makeshift by many mechanics particularly when large or heavy work is under contemplation But the following account by R. V. Hutchinson will be of interest as showing the actual possibilities when doing work in this manner:

The job was a number of large locomotive cylinders for freight engines and was handled by the Ironton Engine Company, Ironton, Ohio, which made the castings, bored and faced the cylinder and valve chests, tested the castings to 250-lb. cold-water pressure and shipped the castings to the customer, who completed the machining himself.

The regular cylinder-boring machine was tied up with other work so recourse was had to a 48-in. lathe for boring out the valve chambers. It was rigged up as shown in the drawing.

A driving plate centered by a plug in the lathe spindle was bolted to the large faceplate (Fig. 29). This plate was bored out to fit the 4½-in. portable boring bar and turned on the outside to fit the facing arms, or sweeps. The upper part of the tailstock was removed, and in its place a bearing was bolted and doweled. This bearing carried a sleeve, holding the other facing arm, and the sleeve was driven by a feather key.

To hold the cylinders, a large cast-iron plate was planed up on each side and a groove cut in one side. This plate was bolted to the carriage. Two angle plates, fitted with keys, had holes bored in them for the hubs of the false heads to fit in. Each false head was lightly fastened to its respective angle plate by two ¾-in. capscrews, and a long bolt was passed through the middle of each false head, holding it securely in place on the cylinder.

The feeding arrangement was originally a star feed, but was

changed to give two speeds to the feed screw and a reverse. Each gear shown has a square hub and a socket wrench with a bent handle, slipped upon the hub of the gear that is required to give a feed in each direction of 1/16 in. per revolution, or 1/4 in. per revolution in only one direction. The feed screw is 1/4-in. pitch. The wrench was made with a long socket, so that it could be turned around and used for easily adjusting the head by hand.

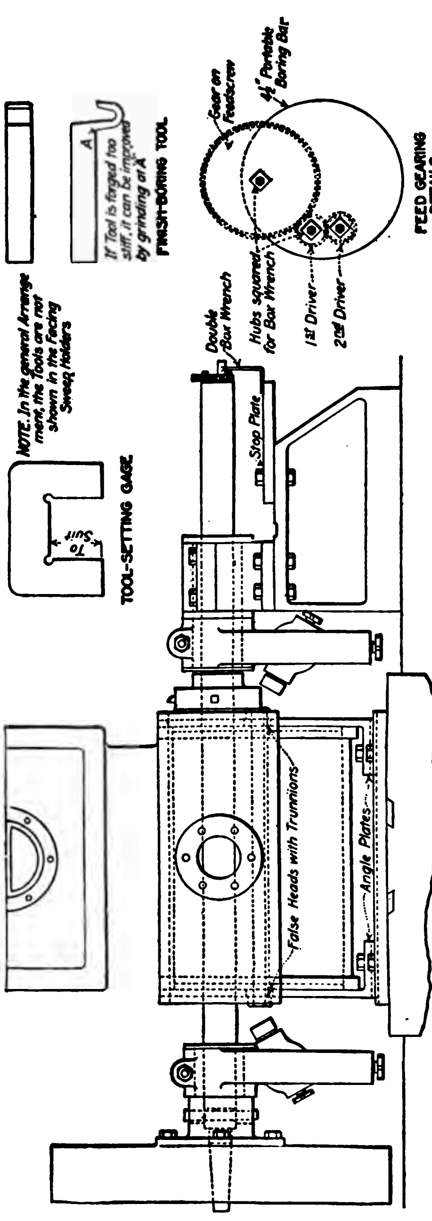


FIG. 29.—Boring and facing valve chamber in a lathe.

To bore a valve chamber, the tailstock is run back along the lathe bed, carrying the bar with it. The false heads and angle plates are secured in the cylinder barrel and the casting lifted upon the lathe. The keys in the angle plates fit the slot in the plate, and screw-jacks under the valve chamber enable the casting to be swung on the false heads so as to clean up true with the layout. The tailstock is run forward, the boring bar entered in the driving casting and pulled up tight against an internal shoulder by the draw-key that accomplishes the driving.

When the job is clamped, roughing tools are set in the boring head to a gage, as shown, and rough-boring and facing each end take place.

The head was turned exactly 12 in. in diameter, so that the making of tool-setting gages presented no difficulty. The type of finishing tool shown has been successfully used on both horizontal and vertical boring machines for finishing cylinders, valve bushings, etc.

Although apparently working under handicaps, this arrangement enabled the valve chambers to be machined at the same rate as that at which similar work had been done on the cylinder-boring machine; in addition, there were duplicate parts for the special machine, should accident make it necessary ever to have a new facing arm and part in a hurry.

PORTABLE DEVICE FOR MILLING PORTS

A convenient piece of portable apparatus is illustrateed by Fig. 30. This is a milling fixture for machining ports in cylinders, and is shown as in use at the Missouri, Kansas & Texas shops at Parsons, Kan.

This milling appliance consists of an air-driven spindle mounted in a head which is adapted to be be fed along the crossrail by means of a hand-operated screw. The rail is attached to a substantial baseplate which is secured by straps to the planed face at the top of the cylinder.

The spindle passes through a threaded quill which forms the means of adjustment vertically, and the head which receives the quill is carried by a cylindrical arm or shank which passes horizontally through the saddle, and which is provided with keyway and feather to prevent it from turning in the saddle. Suitable provision is made for adjusting the milling head forward to locate its cutter properly in the cored ports which require finishing along their edges. The cut taken is naturally not a heavy one and the feed screw is readily operated by hand to pass the mill from end to end in the slot.

CYLINDER HEADS

A common method of handling cylinder-head work is by the application of multiple tools on the vertical mill for boring, facing, turning, recessing, etc.

A method is used in the Lackawanna shops at Scranton, for grinding in cylinder heads where a horizontal lever is attached to the cylinder head and connected to the vertical plunger of a pneumatic pump. The pump has a stroke of 10 in. and operates at about 60 strokes per minute Number 50 grain Carborundum

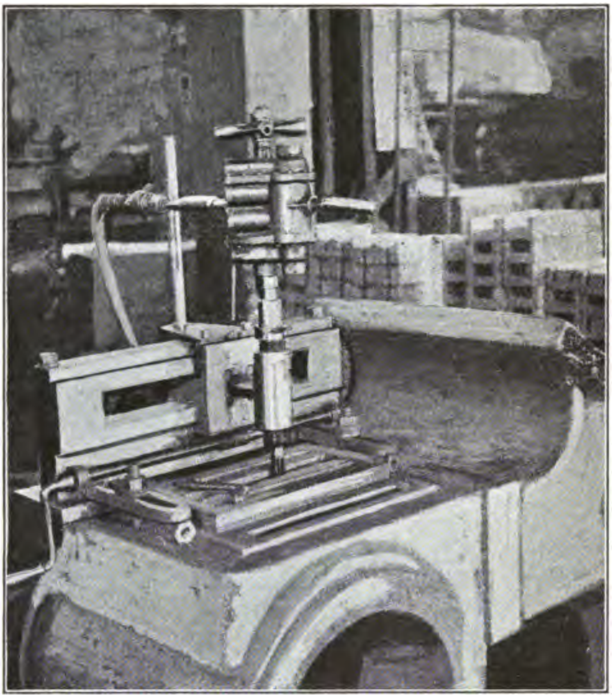


Fig. 30.—Fixture for milling ports.

is fed between the joint of the cylinder and the head, and the pump is started in motion. The head is held so that the joints are in contact by means of a bolt and strap. The pump is allowed to operate for about 1½ hr. and a good steam joint is obtained.

CHAPTER III

MACHINING PISTONS AND PISTON RINGS

One of the important departments of any railroad shop is the section devoted to operations on pistons.

It is common practice to utilize the vertical boring mill for turning and boring piston heads. The photograph reproduced in Fig. 31 illustrates a method of assembling the piston on its rod. Here the rod is secured in horizontal position in a pair of V-blocks mounted upon wooden blocks on the shop floor; a pair of stiff straps across the top of the rod effectually preventing it from

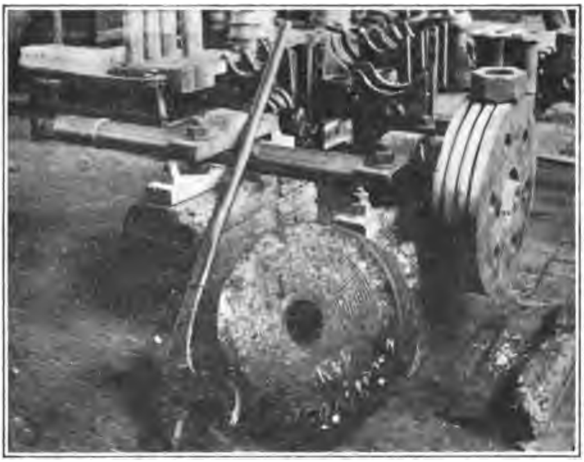


Fig. 31.—Mounting the piston on the rod.

turning while the piston is being secured in place. The end of the rod is threaded for the nut shown lying upon the edge of the piston. The thread is thoroughly coated with white lead before the nut is run into place. The piston and rod end are fitted snugly together; and when the nut is run on and drawn up tight, the piston is held securely against liability of working loose.

The big wrench for tightening the nut is shown in front of the blocks. With its long handle it enables the workmen to apply as much force as necessary to screw the nut up dead tight. A cotter

pin is put through nut and rod end after the nut is in place to keep it from jarring free and turning back upon its thread.

The assembled piston and rod are shown in Fig. 32 in the lathe for the finishing of certain surfaces on the piston. The work is mounted on centers, the purpose of the chuck being to rotate the work through the medium of the cross key, which is placed through the tapered end (or crosshead end) of the rod so that one side of the key comes in contact with one of the chuck jaws and thus acts as a driving dog. The handling of the crosshead itself is described in another chapter.

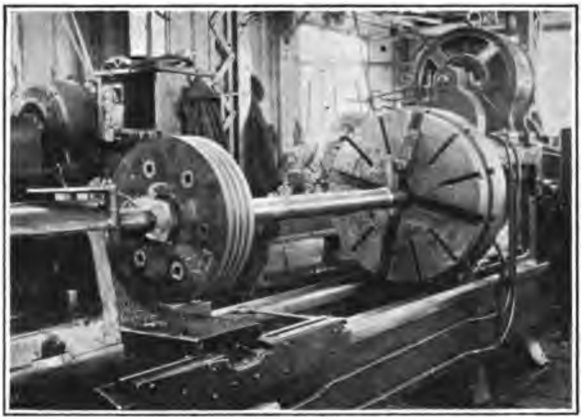


Fig. 32.—The piston in the lathe.

PISTON FIXTURE FOR THE VERTICAL TURRET LATHE

A method of machining pistons at the Oregon Short Line shops, Ogden, Utah, is illustrated in Fig. 33. The boring and turning are accomplished on the Bullard vertical machine with the aid of a special holding fixture which leaves the entire circumference of the piston clear for turning and grooving. While this fixture is low enough to hold the work close to the boring-mill table it still has sufficient height to enable the work to be secured easily. The fixture allows for facing the top surface of the piston, boring the taper hole for the end of the rod, machining the periphery and cutting the ring grooves, all without reclamping or readjusting the work. The only cut which requires a second setting is the counterboring of the seat in the back face off the piston for the face of the nut for the rod.

The method of securing the piston on the fixture is shown in Fig. 34. There are two holes from the back face of the piston, extending into the cored center and as it is necessary to tap these

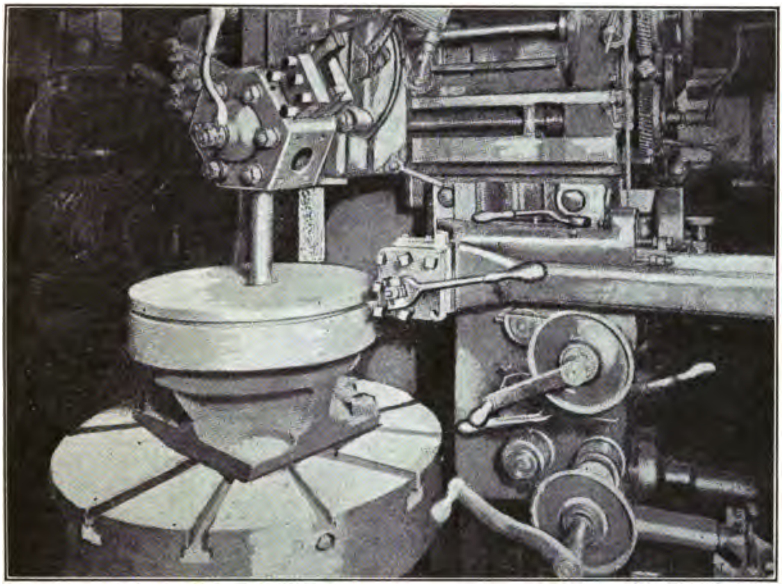


FIG. 33.—Machining pistons.

with a taper tap in order to plug them, the two tapped openings are utilized for attaching the piston to the fixture. Two studs are screwed into the piston as seen in Fig. 34; the work is placed on washers so that the rough face will clear the top of the fixture; nuts are then placed on the lower ends of the two studs to draw the piston down tight on its seat.

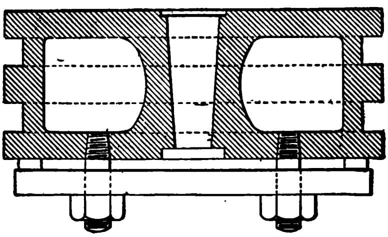


FIG. 34.—Method of holding piston.

In machining the piston it is customary here to face off the top surface with a tool in the turret before starting to bore the hole. The hole is then rough bored and at the same time a turning tool in the side head roughs the outer diameter. Finishing cuts are then taken simultaneously through the bore and on the outside diameter. A square nose tool is run

in from the side to cut the grooves for the rings, an operation distinctly shown in Fig. 33. Thus the machining process is completed with no resetting of the work, except for the short cut referred to in forming the counterbored seat for the piston-rod nut at the under side of the piston.

GROOVING TOOLS AND TAP

The line drawing, Fig. 35, shows a piston grooving tool of the gang type. This is used in the Southern Pacific Company's shops at Sacramento. The tool holder is made to fit the tool

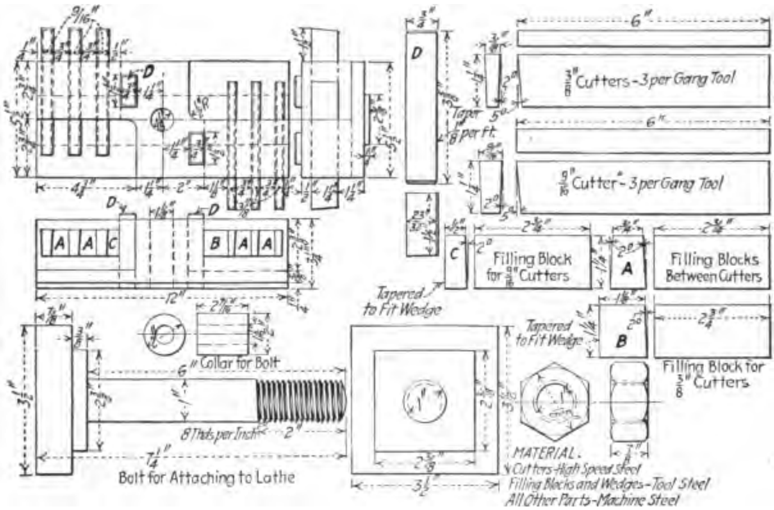


FIG. 35.—Piston grooving tools.

slide on the lathe carriage and carries three 9/16-in. blades or cutters and three at the opposite end which are 3/8 in. wide. These grooving tools are of high-speed steel; the filling blocks and wedges are of tool steel and all other parts are of machine steel.

The tool block or holder has a 1 1/8-in. hole bored through its center for the upright bolt by which it is attached to the lathe. The underside of the holder is made with a tongue for the regular tool post slot in the top of the slide. The cutters are made with a 2-degree taper on each side for side clearance and are ground at the ends to 5-degree front rake. The filling blocks or spacers *A* between the cutters are made with 2-degree taper at the sides in

the reverse direction from the cutter slope to fit properly between the cutters, and the inner filling blocks *B* and *C* are similarly tapered on their faces where they match the cutter sides, while their opposite or inner sides are tapered to correspond to the

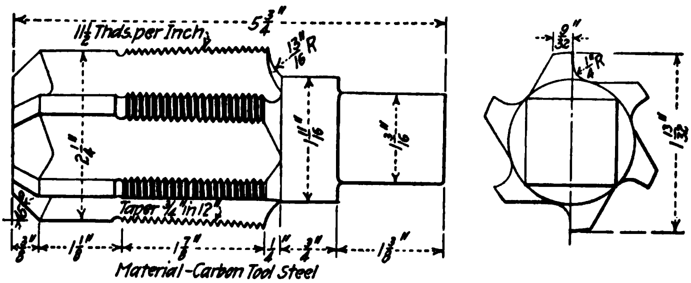


FIG. 36.—Piston head tap.

wedges *D* which serve to lock each gang of blades firmly together. These two wedges *D*, as will be seen, are driven down from the top of the holder into rectangular slots cut vertically through the body of the holder. All dimensions are given on the drawing.

A 2-in. pipe tap for piston heads is shown in Fig. 36. This serves as a combined reamer and pipe tap, the end being chambered to 45 degrees to machine out a cored hole if desired, and the 2¼-in. portion acting as a reamer to size the hole for tapping. There are six lands and these are formed with a ¼-in. fillet at the root of the flute.

A JIG FOR PISTON WORK

A jig used for drilling piston spiders and follower plates is illustrated in the line drawing, Fig. 37. The jig is provided with

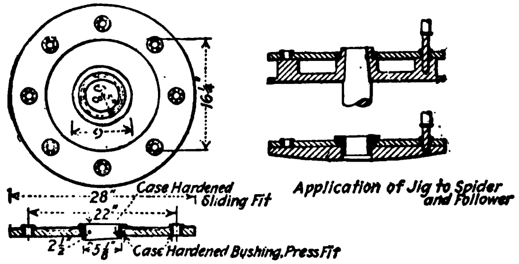


FIG. 37.—Jig for drilling piston spiders and follower plates.

a central bushing hardened and ground to a sliding fit in the cast body of the device so that it may be removed and another size

of bushing slipped into its place; this enables the jig to be used on different sizes of bosses on the spiders or in different sizes of holes in the follower plates, as indicated by the two sectional views at the right in the engraving. The guide bushings for the drills are pressed into place in the usual manner. This jig is one of the Santa Fe shop devices.

PISTON RING OPERATIONS

In Fig. 38 gang tools for the vertical boring mill are shown as used for cutting off piston rings.

The method of machining rings on a vertical machine covers the turning, boring and cutting off of the rings.

Fig. 38.—Piston ring tools.

The cylindrical casting or "pot" for the rings is chucked in the customary manner and the facing and boring are done by tools in the main turret on the crossrail. The operations of turning the outside diameter and parting the rings are accomplished by sets of tools in the side head. The parting tools are of a gang type with offset arrangement. The rings are finished complete in this manner.

FACING LARGE RINGS

A method of facing large piston rings on a boring-mill table is shown in Fig. 39. Here a quick-acting chuck is applied to the table of the vertical mill for holding the work securely while a facing cut is taken across the surface of the ring.

The chuck consists of a set of four jaws which serve to hold the ring from the interior and press it against four properly located stops secured in the radial slots of the table. These internal jaws are really similar to planer "toes" commonly employed

where thin work is to be held on the planer table. They are in the form of short pointed rods placed at a slight angle to the horizontal and when they are set up against the inside of the work they tend to force the latter down securely on to the table.

The four toes are actuated by four straight jaws which are forced outwardly by a flat disk with a bevelled edge. This disk is drawn down to set out the jaws, by means of the binder handle operating on a screw at the top. The outer ends of the flat jaws are also bevelled slightly inwardly so that they will always hold the rear ends of the toes from lifting.

The facing tool is forged and ground to present a slightly angular edge to the work surface and thus produces a smooth even cut when fed across the ring face. This facing method is used at the Sacramento shops of the Southern Pacific Company.

Fig. 39.—Facing piston rings on vertical boring mill.

A somewhat similar chuck is used in some shops for facing and turning rings on the engine lathe. In such cases the chuck is attached to the face plate and the interior jaws in the form of radial arms or pins are expanded by a taper plug which is screwed into the fixture and which bears against bevelled surfaces at the inner ends of the pins.

PISTON ROD WORK

A grinding operation on piston rods is illustrated in Fig. 40, as accomplished upon a Norton machine. The grinding machine is necessarily of the gap type to allow the head of the piston to swing clear of the bed. Both the straight portion of the rod and the tapered end for the crosshead fit are finished in this manner with the work given additional support against the cut of the

abrasive wheel by means of the steady rests at the front. The operation of the grinding wheel produces a true, cylindrical, and smooth surface with little expenditure of time and labor, the rod illustrated being ground to finish dimensions in less than 25 min.

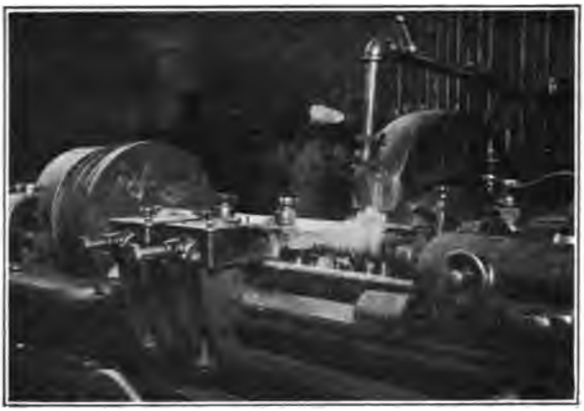


Fig. 40.—Grinding piston rods.

ROLLING TOOL FOR RODS

Where the grinding machine is not available piston rods are commonly finished by rolling. The arrangement of the rolling tools differs in different shops, but the principle is one of carrying a hard roll against the work to compress the surface metal and size the work to a good wearing surface for the packing as the roll is fed along with the lathe carriage.

One device of this kind is composed of a heavy forged yoke which encloses the piston rod, the end being bent so as to permit of clamping in the tool block on the lathe carriage. The bent end or shank has a projection which is notched to catch and hold the end of the rolling tool frame. The frame is made in two parts, like a ring clamp, which are fastened together by a link at the back so as to permit of easy adjustment for different sizes of piston rods. The upper half of the frame carries two rollers which are glass hard, while the lower half carries one hard roller. The rolls are in each case about 3 in. in diameter with a face ½ in. wide. There is an oil pipe running to the center bearing of each roll.

With this device placed around the piston rod, the lathe is started, the rollers forced down to their proper place by the clamp nut, the carriage feed thrown in and the rollers forced along over

the rod, compressing it to the desired diameter and giving good results.

PISTON ROD PACKING TOOLS

The brass ring shown at the left in the half tone, Fig. 41, is a housing ring for metallic packing for piston rods. This ring is

FIG. 41.—Tools for finishing brass housings for metallic packing.

one of two which enclose the packing between them, and the inside of each housing ring is bevelled out to an angle of 30 degrees to correspond to the taper on the outside of the packing rings which are enclosed by the housing. The housing rings are made

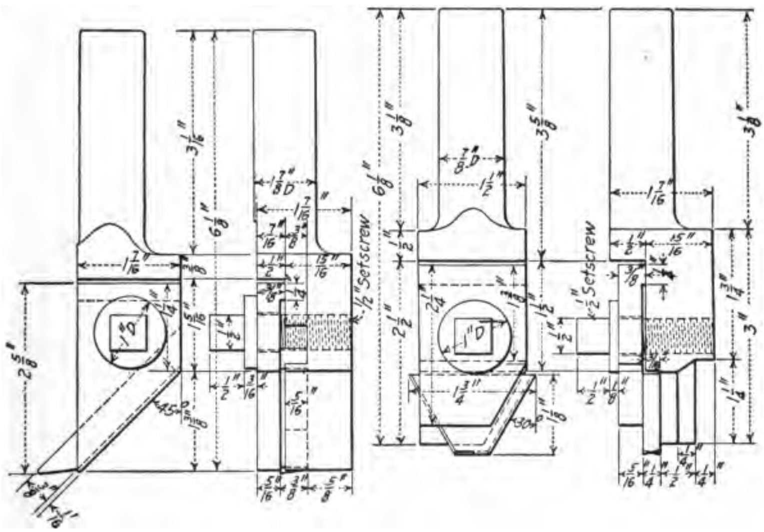


FIG. 42.—Details of housing tools.

in halves as indicated in the photograph and they are machined by means of the brass lathe tools shown at the right in Fig. 41. These tools are seen more in detail in the line drawing, Fig. 42. They require little description as the two views show

all details clearly. The tool at the left is of course for turning and facing the cast brass ring; the tool at the right for machining out the inside to the 30-degree angle. The method of locating and clamping the tools in their holders will be understood without explanation.

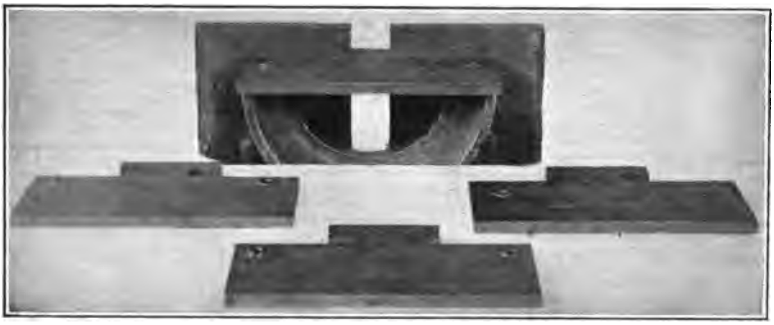


Fig. 43.—Interchangeable drill jigs for dowel holes in packing housing.

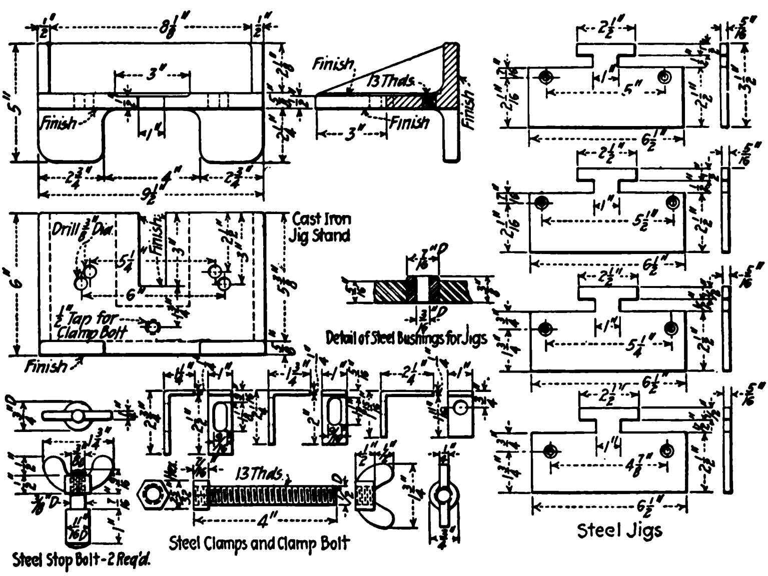


Fig. 44.

INTERCHANGEABLE DRILL JIG FOR PACKING HOUSINGS

The photograph, Fig. 43, illustrates an interchangeable drill jig for various sizes of these housings. The two halves of the housing ring are located together by dowel pins in their joint

faces and the drill jig, Fig. 43, is used for drilling the dowel-pin holes. The one jig base with four interchangeable plates covers the different sizes of housing rings.

Referring to the photograph, the jig body is in the form of an angle plate, the base of which is hidden by the jig plates shown lying on the casting in front. There are two stop bolts in the face of the angle to locate and support the half housing, and these together with a small clamp at the bottom secure it in place for drilling. The drill plate locks into the vertical slot planed in the angle and the plate is easily slipped in and out for changing from one size of housing to another.

All details of this jig are covered in the drawing, Fig. 44, and the drawing includes details of the four plates as well. The jig body or base is of cast iron. The jig plates are of machine steel with hardened and lapped steel guide bushings for the drills. The stop bolts and their wing nuts are seen in the left lower corner of the drawing.

CHAPTER IV

PISTON VALVES, CAGES AND RINGS

A piston valve assembled and a set of parts for another complete valve are representd in Fig. 45. The line drawing, Fig. 46, shows construction details of both valve and cage or sleeve: As indicated in Fig. 46, the valve proper consists of a cast-iron center 28 in. long by 11¼ in. in diameter across the ends. The center or body is fitted to a pair of spiders bored out and keyed to the valve rod, the latter being turned to 2 in. in diameter at

Fig. 45.—Piston valve parts assembled and taken apart.

the points where it passes through the hub of the spiders. These spiders are clearly shown and they carry in each case a bull ring and a pair of packing rings which, like the bull rings, are of cast iron.

The packing rings as made at the Sparks shops are finished $\frac{1}{32}$ in. larger and then cut, that is they are turned to $12\frac{1}{32}$ in. in diameter before sawing through. The bull rings are turned to

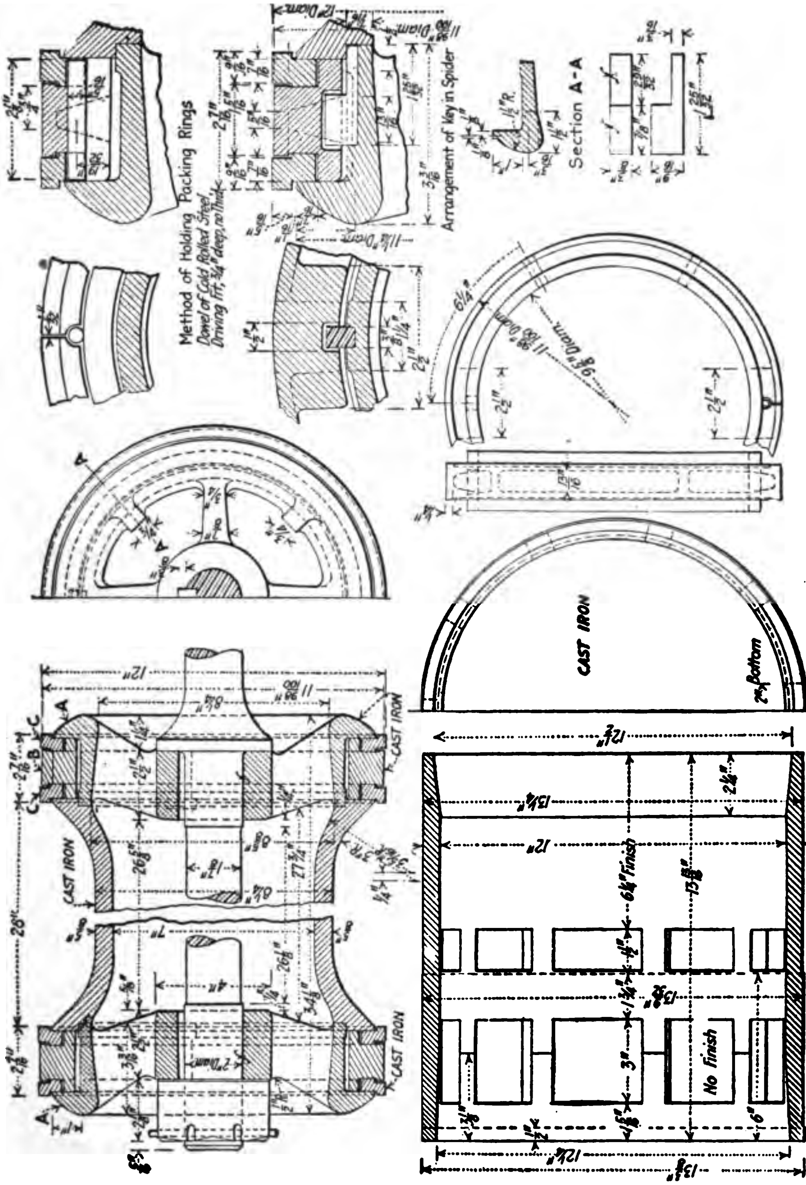


FIG. 46.—Construction details of piston valve and cage.

11.980 in. in diameter, or 0.02 in. under size. The method of locating the bull rings on the spiders by means of rectangular keys is shown by the detail section in Fig. 46, and the method of holding the packing rings in each bull ring by a dowel-pin is also represented by the sketch in the upper right-hand corner of the drawing.

In the lower left-hand corner of this illustration will be seen the end view and longitudinal section of the steam-chest liner, or valve cage, in which the piston travels. The dimensions of this cage are all given on the drawing, and the form and location of admission and exhaust ports are also shown clearly.

MACHINING THE VALVE CAGE

The half tones, Figs. 47 and 48, show lathe operations in the machining of the valve cage. The gray iron casting is gripped

FIG. 47.—Boring the cage for piston valve.

for the boring operation in a four-jaw chuck, and a heavy bar with inserted tool is used for boring the internal diameter. It is the custom to bore the cage a few thousandths over standard size and to turn the outside diameter large by a corresponding amount to allow for pressing tightly in the steam chest, the slight closing in of the walls of the cage, which are ⅝ in. thick, bringing the internal diameter to the standard size of 12 in., as indicated in Fig. 46.

In turning the cage, as in Fig. 48, the cage casting is, in this shop, placed on an arbor that receives the work on two slightly

conical disks, or flanges, which locate the casting true with the bore, as shown by Fig. 49. Here the arbor proper, which is a 3¼-in. steel mandrel, carries the cast-iron body *A* which has the cone-shaped flange or disk, at *B* and a second flange at *C*. The latter carries a headless screw which enters one of the port

FIG. 48.—Turning operation on piston valve cage.

openings *D* and serves as a positive driving medium for the work. The carrier *A* is forced tight on the arbor and carries the driver *F*, by which the whole arbor is rotated from the lathe face plate or from one of the chuck jaws. The opposite cone disk *G* is a sliding fit on the arbor and is adjusted inwardly to a snug posi-

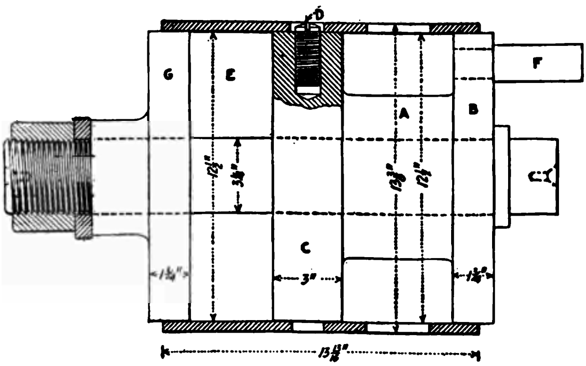


FIG. 49.—Arbor used in turning a valve cage.

tion in the work by means of the nut on the threaded portion of the arbor. The cone-bearing surfaces for receiving the cage to be turned are finished true on the arbor centers, and the work when properly secured by the means referred to is turned concentric with the bore by which it is located on the arbor.

The admission ports in the valve cage have to be machined along their edges to give a clean, sharp, steam line. The exhaust ports do not require accurate finishing in this manner. For the machining of the ports by a simple method, the valve cage is set up on the table of a milling machine as shown by Fig. 50, and a small end mill is applied in the manner represented. The ca e is of course readjusted for the milling of each port.

The ports are 1½ in. wide in this size of cage, and 2¾ in. long, allowing a ⅝-in. end mill to be used to advantage. The cage

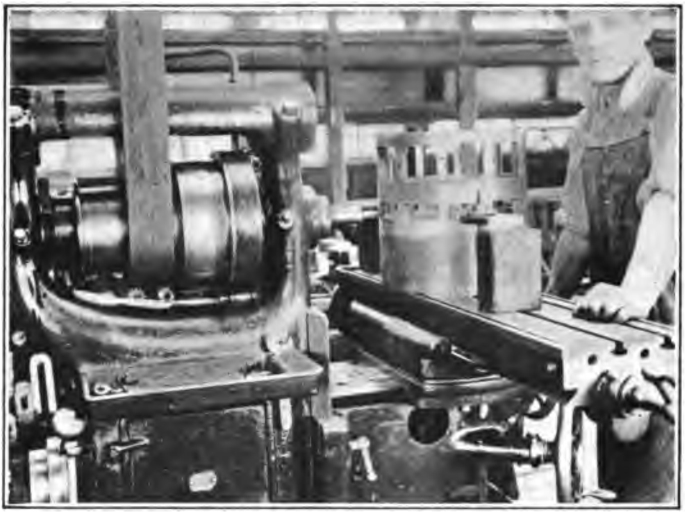


Fig. 50.—Milling ports in valve cage.

is set up on end and secured by a pair of straps and bolts, and the ports are then milled to layout by the operation of the regular table feeds of the machine.

ANOTHER METHOD OF BORING AND TURNING CAGES

The halftone, Fig. 51, illustrates a boring head for piston-valve cages, which is made up of a casting carrying three boring cutters, each 1 in. square, the boring head itself being mounted upon a shank reduced at the rear end to fit the taper hole in the tail spindle of the lathe. The three cutting tools fit into slots in the face of the boring head and are held therein by clamps across their outer faces.

The cage to be machined is held to the lathe faceplate by a set of four chucking jaws as seen in Fig. 52. These jaws are designed

FIG. 51.—Special boring head for valve cages.

to permit the work to be bored and turned simultaneously, and they hold the casting without the possibility of springing it because of the undue pressure of the clamping jaws. The clamp-

FIG. 52.—The boring head in operation.

ing method will be understood from this view and from the sketch, Fig. 53.

Referring to the latter engraving, it will be seen that the inner end of the valve cage casting is provided with an extension for the purpose of holding it to the faceplate, this extra metal being scrapped when the cage is cut off after boring and turning to size. Inside of the casting there is an annular ledge with an angle of 45 degrees which provides a gripping surface for the hooked inner ends of the four clamping jaws. Opposite the dovetail mouth of the jaw there is a pair of clamping screws with a steel shoe under each to seize the edge of the work between jaw and shoes.

In placing the cage casting in position, three jaws are loosened on the faceplate of the lathe, and the fourth is allowed to grip it

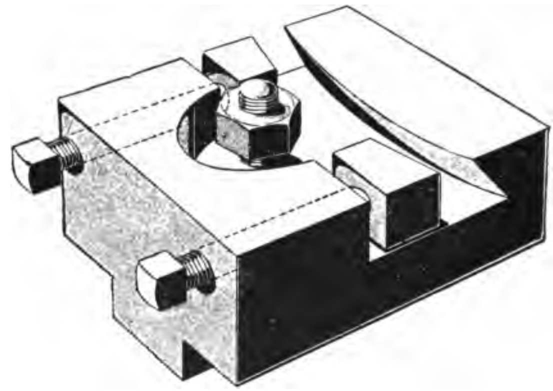


FIG. 53.—Jaw for chucking pistons.

tightly while the other three remain floating on the faceplate. Setting up the two screws of the jaw tightens the work in the mouth of the fixed jaw, and then the other three jaws are located in their radial slots in the faceplate by the edge of the work itself, after which they are secured fast to the faceplate by the nuts on their square-head bolts. The individual pairs of tightening screws in each jaw are then set up to grip the work securely between the clamping shoes and dovetail surface on each jaw.

A VALVE CHAMBER BUSHING MANDREL

Another mandrel or arbor for turning valve-chamber bushings or cages is shown in Fig. 54. The tailstock here carries a slightly coned disk to fit the tapered end of the cage and the headstock is fitted with a head which is also slightly tapered to correspond to the tapered interior of the cage end. At the back end of the

mandrel head there is a threaded portion as shown, upon which is mounted a ring nut adapted to be operated by a pin wrench.

The thin ring shown resting against the front end of the chuck is a backing off or spacing ring placed on the mandrel before the work is put in place. This prevents the mandrel from being crowded too tightly into the work and when the ring nut is turned it acts upon the thin ring to force the work from the mandrel. The large ring at the front in the photograph is an adapter for a larger size of valve chamber bushing.

FIG. 54.—Fifteen-inch valve cage or chamber mandrel.

ATTACHMENT FOR MILLING PORTS IN CAGES

A special multiple spindle attachment for milling the ports in valve cages or bushings is used in the Union Pacific shops at Omaha. The base of this fixture has a rotary movement derived through the medium of a worm wheel and worm, operated by a ratchet. This may be actuated by hand or by power by connecting it to an eccentric on a shaft located behind the column of the milling machine.

The attachment carries four cutter spindles spaced to suit the center distances between the ports to be machined. The attachment is placed vertically on the milling machine head and derives its drive from a central gear shaft which has a shank fitting the hole in the spindle nose of the miller. Suitable gear trains connect this driving gear with spur gears on the cutter spindles.

The work is fed back to the end mills by the cross movement of the table and then rotated to mill the ports to the required length. This rotary movement is then followed by the withdrawing of

the work to the front, and indexing it for the next row of openings, after which it is fed again to the end mills.

JIGS FOR STEAM CHEST VALVE CHAMBER AND VALVE

The jig in Fig. 55 is for drilling the stud holes around the face

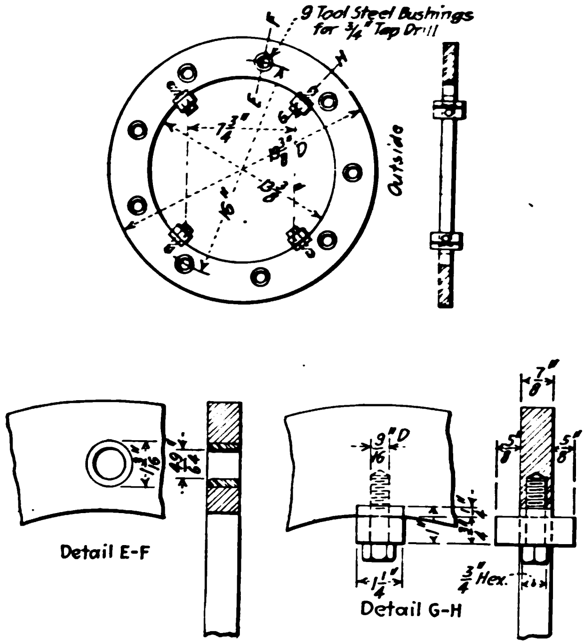


FIG. 55.—Steam chest jig.

fo the steam chest for the head. This has nine 49/64-in. guide bushings spaced about a common circle. There are four locating

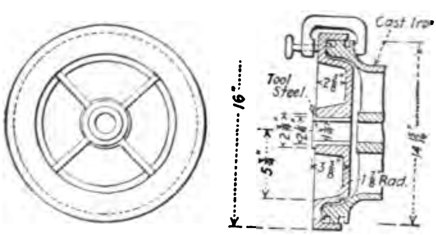


FIG. 56.—Template for drilling valve stem holes.

stops set into the inner bore of the ring and secured firmly in place by screws as shown. The jig is used from either side for chest and head.

The jig in Fig. 56 is for driling the valve-stem holes. This jig fits over the end of the valve and is secured by a C-clamp. It carries a central bushing for the jig operation.

FORCING BUSHINGS OR CAGES INTO PLACE

In Fig. 57 a valve cage is shown at the side of the locomotive ready for forcing into place in the chest. While the walls of the cage are, say, ¾ in. thick, the numerous openings for the ports

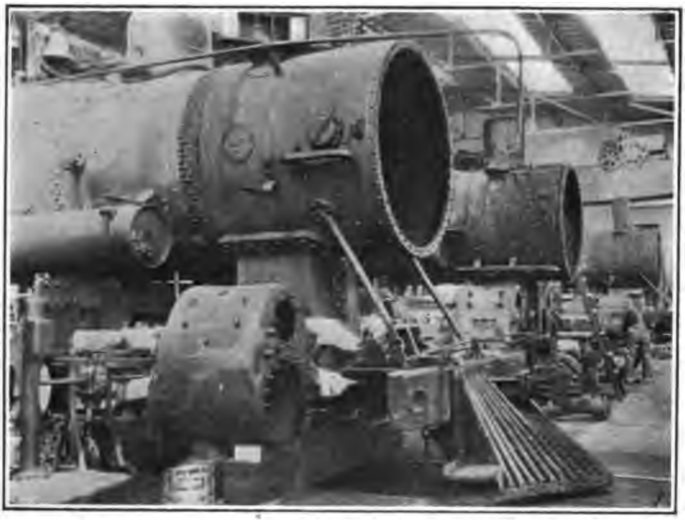


Fig. 57.—Valve cage ready for forcing into steam chest.

reduce the section around the circumference to a degree where care and judgment must be exercised in forcing the cage into the chest, in order to avoid the possibility of rupturing the narrow walls between the ports. The cage must be started into place squarely and drawn home firmly without cramping it by unequally applied force at different points around the outer end or edge of the casting.

The apparatus for accomplishing this operation, usually consists of a long, heavy, threaded rod or screw, Fig. 58, which carries at one end a plate to bear against the end of the cage, while the nut at the other end of the screw abuts against a second plate resting across the end of the steam chest. Suitable means

in the way of long ratchet or other device are applied to the nut to draw the threaded rod back and to force the valve cage firmly into its position in the steam chest.

FIG. 58.—Outfit for forcing valve cages or bushings into place.

OPERATIONS ON PISTON VALVE RINGS

Referring back to Fig. 46 it will be seen that the piston valve rings there shown are made with double offset; though with some classes of valves the rings are formed with single offset only. In either case the offset design enables the rings to be locked in by the bull rings and this prevents the valve rings from springing into the ports or from dropping in in case the ring should break. The engravings below represent some features of the tool equipment for machining both single and double offset rings as made at the Sacramento shops of the Southern Pacific Company.

The turning and cutting off of the ring is accomplished in a Libby turret lathe, the turning being done as shown in Fig. 59. Here a casting long enough for 12 rings is gripped in the chuck jaws and a roughing cut taken with a tool held in the turret block on the cross slide of the machine. This turret also carries the set of 12 cutting-off tools seen in the illustration. The barrel or sleeve casting from which the rings are to be cut is turned to 1/16 in. over size in the roughing cut, the metal removed on a side being about 1/4 in. The feed for turning is 1/32 in. per revolution. This 1/16 in. is the amount left for finishing and compression and

spring in the ring when finished. That is, after the rings are cut off in the turret lathe as described later on in this chapter, they are put into a form or jig, which is bored $\frac{1}{32}$ in. above size, and here an arbor is put in with plates for clamping the rings for finish turning after they have been slipped out of the form. As the form or jig is $\frac{1}{32}$ in. above size, and, as the rings are placed therein when they are themselves $\frac{1}{16}$ in. over size, there is a compression of $\frac{1}{32}$ in. required to put them into the form or jig. Consequently, when the rings are finish-turned they still have $\frac{1}{32}$-in. spring for actual operation.

FIG. 59.—Turning the barrel from which rings are cut.

THE CUTTING-OFF AND BORING TOOLS

Now, to return to the cutting-off operation: In Fig. 60 the cross-slide turret is shown with the 12 tools withdrawn from the ring casting and a special turret tool head is seen carrying cutters for operating upon the face and interior of the outer ring. The process is first to feed the cutting-off tools part way through the casting wall, then withdraw the tools, reset $\frac{1}{16}$ in. to the side by adjusting the cross-slide carriage, then feed the multiple cut-off tools in again, thus forming the offset at one side of the rings. The metal at the inside of the ring casting still holds the whole sleeve casting intact and the outer face (or end face) of the ring is machined before the ring is cut off from the casting.

In Fig. 60 the facing and boring tools in the head on the main turret are shown. The facing tool acts as a recessing device to

bore out the face of the ring to the depth required for the offset on that face of the ring. This tool is carried by an auxiliary slide and tool holder seen at the front of the special tool head in the

FIG. 60.—Gang tools and turret tools in position in work.

main turret. A better view of this auxiliary device is obtained from Fig. 61. It consists of a body attached to the main tool head, and in this a slide is operated by hand wheel and screw to

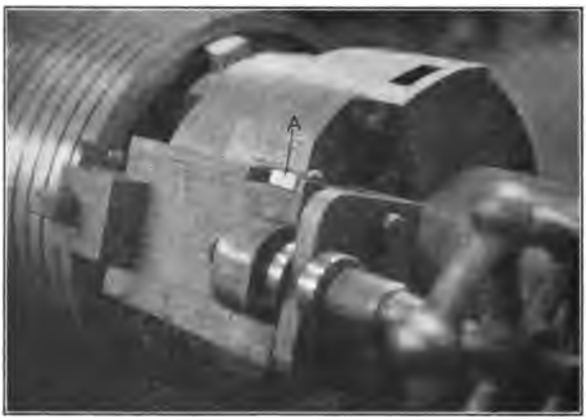


FIG. 61.—Auxiliary facing tool in turret.

feed the tool parallel to the axis of the work. There is a stop block or thickness gage *A*, which allows the tool to be fed into the ring to face out the recess to exact depth. The tool is then

withdrawn and the boring tool on the main head of the turret is then fed in to bore out the interior of the ring and thus sever it from the sleeve casting. The operations of facing each successive ring and boring it to size the interior and the cutting off of the ring from the inside is thus continued until the 12 rings in the casting are finished. The thickness of the rings, as determined by the operation of the multiple cutting-off tools in the carriage block, is held accurately to dimension by snap gages giving a total limit of 0.001 in. The boring tools, auxiliary facing tool slide and the finished rings are shown clearly in the half tone Fig. 62.

FIG. 62.—Boring head, facing tool and finished ring.

The boring out of the rings as above requires the removal of about 1/16 in. of metal on each side, this being accomplished in one cut. The speed of the work while the cutting-off tools are operating is 8 r.p.m., or a surface speed of 26 ft. per minute. This enables the series of tools to operate without chatter and gives a smooth surface where the tools are run in the second time for facing down to the shouldered offset. The original casting for the 12 rings is 13 in. long and only 1 in. of metal is lost in the grip for the chuck jaws.

OTHER TYPES OF BORING AND CUTTING-OFF TOOLS

The line drawing Fig. 63 illustrates another design of boring head for operations on piston valve rings, and the same drawing

includes a multiple tool-block holder for six parting tools. This equipment is also made for use on a big turret lathe. The boring head is mounted on a bar which is bolted to the main turret face

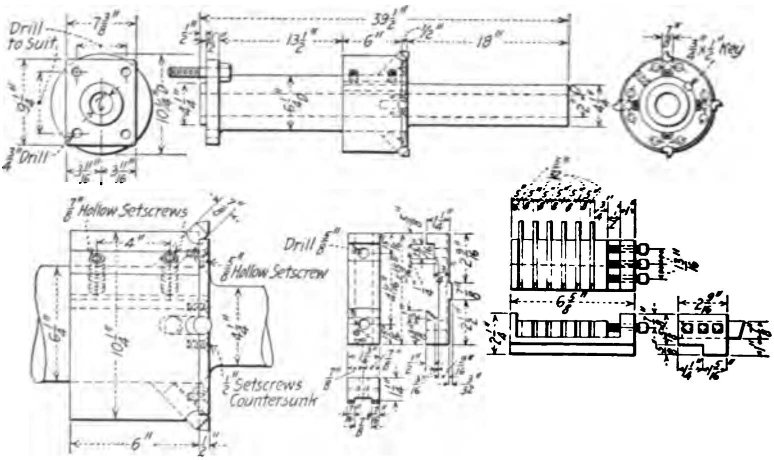
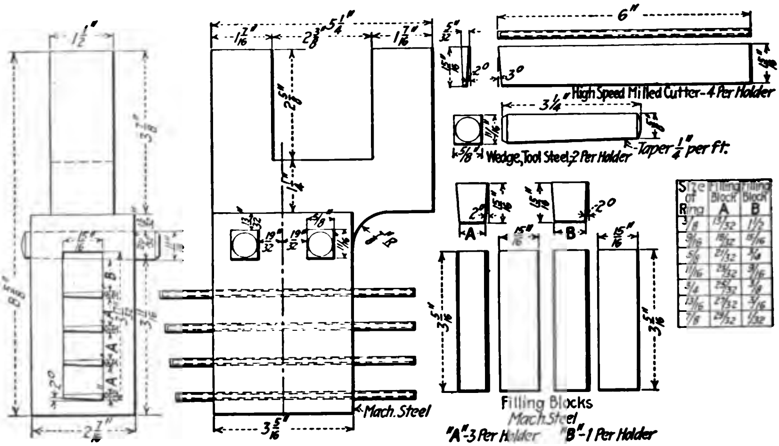


FIG. 63.—Piston valve tools.

and the outer end of the bar is piloted for support in the usual manner. The head carries four boring tools which are ⅞ in. in diameter and these are placed in the head at an angle of 45



Size of Ring	Filling Block A	Filling Block B
3/8	13/32	1/2
9/16	15/32	5/16
5/8	21/32	3/8
11/16	23/32	3/16
3/4	25/32	1/8
13/16	27/32	1/16
7/8	29/32	1/32

FIG. 64.—Gang tool for vertical mill.

degrees. The head is keyed to the bar and secured by hollow head set screws as shown by the drawing. The cutters are also acted upon by hollow head screws.

The multiple-tool cutting-off block is provided with spacing blocks to separate the tools by the desired amount for the width of ring. The set of tools are clamped tight in the holder by three set screws at the right-hand end.

A gang toolholder for the vertical mill for use on both valve and piston rings is illustrated by the drawing, Fig. 64. This carries four cutting-off tools offset at the points in the usual fashion to cut off one ring after another. The tool blades or cutters are cleared at the sides to an angle of 2 degrees and the blocks between and for filling at the end are similarly bevelled along their sides. The whole group of tools with the spacing blocks are locked in their holder by a pair of tapered keys as shown. The cutters are of high-speed steel milled to the desired bevel along the whole length of the blade. The wedges are of tool steel and the filling blocks of machine steel.

A METHOD OF REMOVING VALVE BUSHINGS

In this chapter on piston valve work brief reference may be made to an interesting method of removing valve bushings from cylinders where difficulty has been found in pulling them out with bolt and nut. Writing on this subject, A. Krausbek refers to a hydraulic press which was designed for the purpose referred to. This oufit is illustrated in Fig. 65.

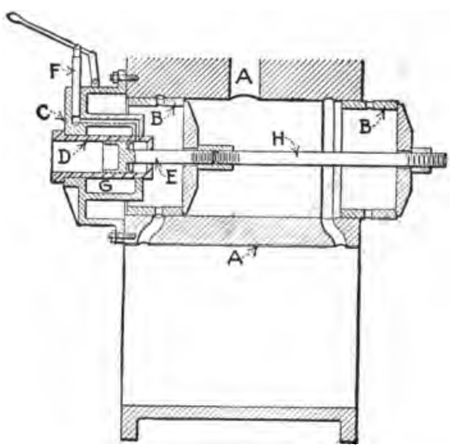


FIG. 65.—Details of hydraulic press for removing valve bushings.

Here the locomotive cylinder is shown at *A*, the bushings at *B*. The hydraulic press is shown at *C*. This carries the press cylinder *D*, the ram *E*, the pump piston *F*, the reservoir *G* for the fluid. At *H* is an extension for the ram piston rod. The ram and ram rod are provided with hydraulic, leather cup packing, and a hydraulic pressure gage shows the pressure of the fit.

The pump cylinder is made of soft steel and bolted to the cast iron frame *C*; the cylinder *D* is from an old hydraulic jack cylinder.

CHAPTER V

TOOLS FOR CROSSHEADS AND GUIDES

A few views of the babbit shop tools in one of our railroad repair plants are reproduced below.

Figures 66 and 67 represent a single-bar crosshead before and after the babbitting process has been accomplished.

It is the practice at these shops to grind the crosshead guides true and parallel, caliper the width of the guide and set the babbitting fixture by the calipers, for pouring the metal into the crosshead. The fixtures for babbitting blocks for single-bar crossheads and gibs for double-bar crossheads are so devised as to

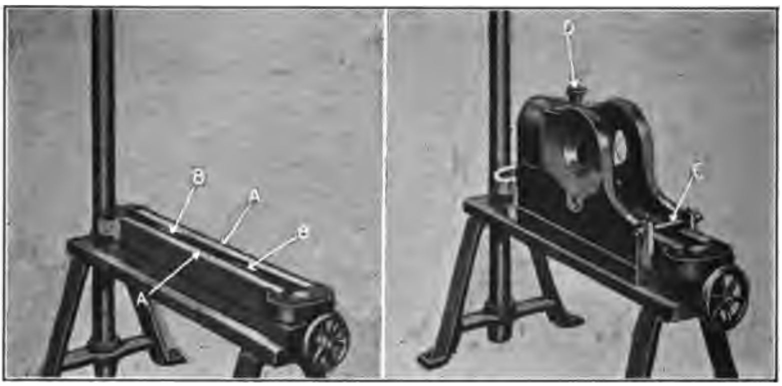


Fig. 66. Fig. 67.

Figs. 66–67.—Babbitting crossheads.

run the proper thickness of metal upon these parts. When the crossheads and their blocks and gibs have left the babbitting fixtures no fitting of any kind whatever is required in mounting the crossheads on their guides.

DETAILS OF THE FIXTURES

Referring again to Fig. 66 it will be observed that the babbitting fixture consists of the two parallel jaws A, whose inner faces are tapered from the ends toward the center. Between these jaws are two wedge blocks B, which are drawn toward one another

to expand the jaws, or are separated more widely to allow the jaws to close, by means of a right- and left-hand screw operated by the handwheel in front. The jaws are held in contact with the operating wedges by two C-springs at the ends.

After the ground crosshead guide has been calipered for the width of its bar, the expanding babbitting fixture is adjusted by the handwheel to the calipers. The crosshead suspended from the air hoist is then dropped into place as in Fig. 67 and a stop clamp *C* placed at the ends as shown. Shredded asbestos mixed with water until in heavy plastic condition is applied to the open

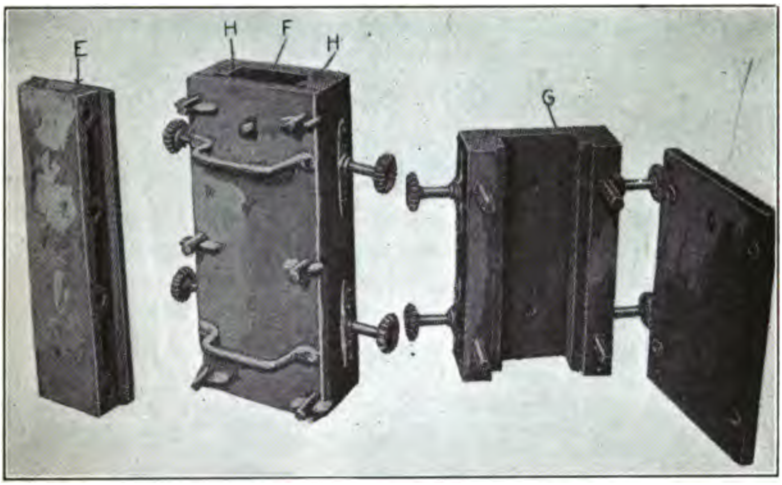


FIG. 68.—Babbitting fixtures for crosshead blocks.

joints between work and fixture to prevent the babbit from running out. The hot metal is then poured down the runner *D*.

The tube extending from the funnel top of this runner is bent off center sufficiently to project directly over the opening to be poured in one side of the crosshead, and after the first face has been poured the runner is swung half way around, bringing its lower end over the opening for the other face of the work.

SHOE FIXTURES

Two fixtures for babbitting shoes for single-bar crossheads are illustrated in Fig. 68. A shoe of this nature is represented at *E* and its fixture at *F*. A similar babbitting fixture for a smaller size crosshead shoe is shown at *G* with the cover removed.

This type of fixture is an open-ended box with two gibs at *H*, which are pressed by handscrews against the side of the crosshead shoe *E* when this is in place in order to close the cored openings along the sides of the shoe.

The cover of the fixture is secured in place, after the work is seated, by taper wedges driven lightly into oblong openings in the studs which project through the cover. About $\frac{3}{16}$ in. of metal is run on to the faces of the work, this being practically the same thickness as the babbitted surfaces poured in the crosshead itself.

Both the crosshead and its shoe come from the babbitting fixtures with very smooth surfaces, the work and the fixture being warmed prior to the pouring operation. Block tin is used in the process. The melting pots have a capacity of about 250 lb. each.

BABBITTING GIBS

The fixture for babbitting gibs for "two-bar" crossheads is made up of a pair of taper bars, corresponding to a large adjustable parallel, with width varied at will by manipulation of the screw threaded into the broad end of one of the tapered bars.

This fixture, like the one shown in Figs. 66 and 67, is set by calipers to correspond with the width of the guides. The above babbitting fixtures are shown as photographed at the shops of the Colorado & Southern Railway Company, Denver, Colo.

OTHER BABBITTING FIXTURES

The sketches in Figs. 69, 70 and 71 show a method of babbitting solid crossheads as described by J. K. Long.

First, a back cylinder head is bolted to the wall of the shop or one of the columns, as at *A*, Fig. 69. In using, a wooden distance piece, as shown, is put in the cylinder-head counterbore, next the large end of the babbitting mandrel *B*. Then the adjustable bushing *C*, which is in three parts held together by a spring band, is put in the piston-rod end of the crosshead and this is put on the mandrel *B*. The upper piece, representing a guide and adjustable as to width, is put in place and set to proper width to suit guides of locomotive to which the crosshead belongs. The series of graduations in Fig. 86 shows the range of sizes from $6\frac{7}{32}$ to $6\frac{35}{64}$ in. The clamp *D*, Fig. 70, is for holding the forms in place,

while the small jack-screw *E*, Fig. 69, is for raising or lowering the end of the crosshead as may seem necesssary. The babbit is then poured.

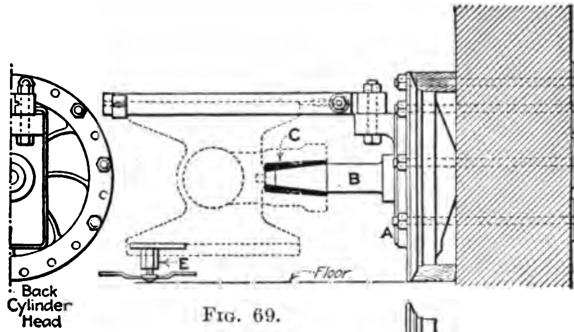


FIG. 69.

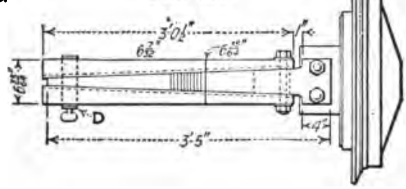


FIG. 70.

FIGS. 69–70.—An adjustable babbitting fixture.

Another mold for babbitting solid crossheads and those having shoes is shown in Fig. 71. The spindle *A* is put through the crosshead, the large tapered part being made to fit the bore at the

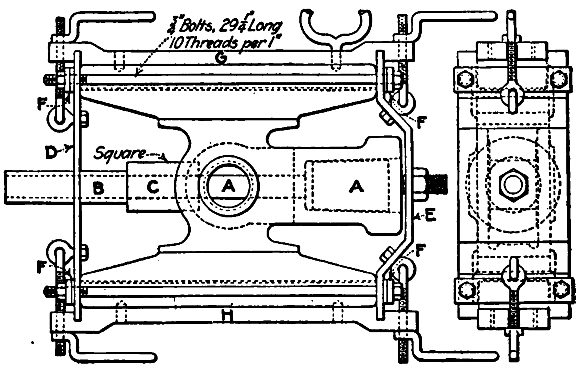


FIG. 71.—Another type of babbitting fixture.

piston-rod end. Then the sleeve *B* is put in from the opposite end over the spindle *A*, the square tapered part *C* entering where the front end of the main rod goes in. Next the end plate *D* is

put on and tightened, then plate *E*, both of these plates having eye-bolts shown, and cross-end plates *F* are put in place and tightened by the long through bolts. The top and bottom forms are put in place and the eye-bolts swung into the slotted ends and tightened. By using gages of different thicknesses, the distance between the mold and the crosshead shoe can be made to suit.

The large eye-bolts are for the purpose of picking up the mold after pouring, as it gets very hot. The molds *G* and *H* are usually made of three different thicknesses to suit requirements and are $\frac{1}{32}$ in. less in thickness at bottom than at top to facilitate easy removal. When assembled, the entire rig can be set on a small

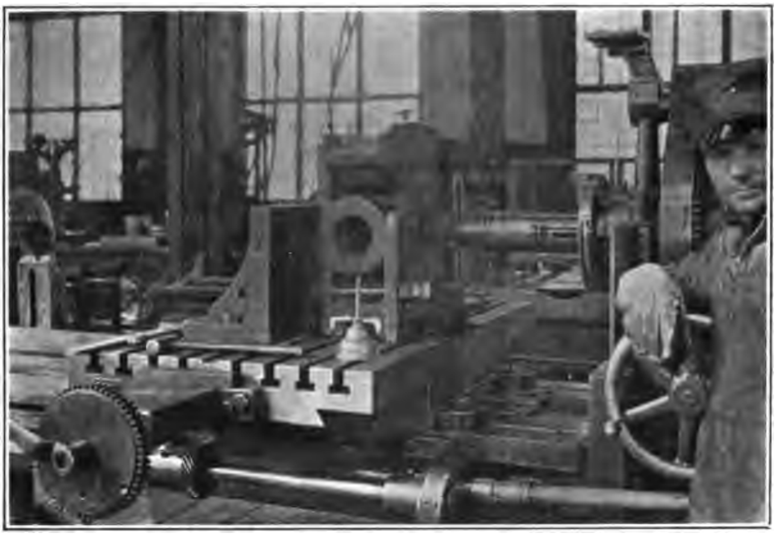


FIG. 72.—Taper reaming of crossheads.

horse or stand, and after one side is poured it can be easily swung over to pour the other side.

WRIST PIN HOLES

The crosshead in Fig. 72 is represented in position on the table of the horizontal boring machine for the taper reaming of the wrist pin hole. The crosshead rests upon the machine table, but it is securely strapped against parallels held to the upright face of an angle plate. The body of the pin, as shown by the typical drawing, Fig. 73, is 4 in. in diameter, and the taper portion

is ¼-in. taper in 5 in. or 0.6 in. per ft. The body of the crosshead is of cast steel, and the bearing surfaces for the guides are babbitted in the manner indicated; that is, the babbitt is poured into 12 dovetailed seats formed in the sides and bottom of the bearing surfaces, the relative areas of babbit and casting forming the bearing being clearly illustrated. The piston rod, as will be seen, is connected to the crosshead by taper fit and further held by the large flat taper key shown in the detail in Fig. 73. The key measures over the wedge proper, 9½ in. in length and

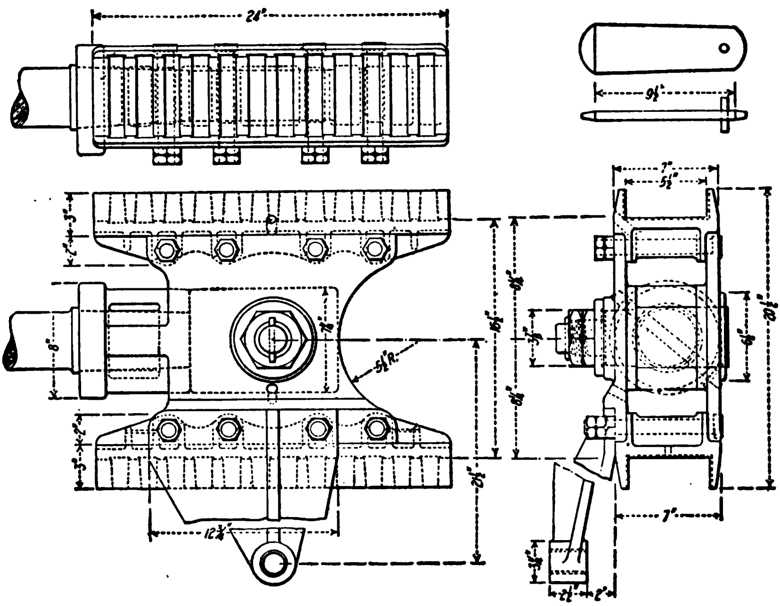


FIG. 73.—Details of a locomotive crosshead.

¾ in. in thickness. Its taper is 3/16 in. in 8 in. (the distance through the neck of the crosshead) or 9/32 in. taper per foot. This taper key is locked endwise by a No. 4 taper pin. The drawing shows all of the features and others of interest.

TAPER REAMER DETAILS

The line drawings, Fig. 74 to Fig. 77, give full details of a series of spiral-fluted, taper crosshead reamers, the layout covering five sizes. These range from 2½ to 4⅛ in. in diameter at the small end of the reamers. The numbers of flutes range from

10 in the smallest size of reamer to 17 in the largest in the series. All sizes are fluted with left-hand spiral cut to a lead of 62 in. in one turn, or as commonly expressed, to a pitch of 62 in. The flutes are cut $\frac{1}{4}$ in. deep and with their faces radial. As shown by Fig. 75 there is a square groove to break up the cut milled directly opposite the flutes, which is $\frac{1}{8}$ in. deep by $\frac{3}{16}$ in. wide. The lead of this right-hand groove is 1 in.

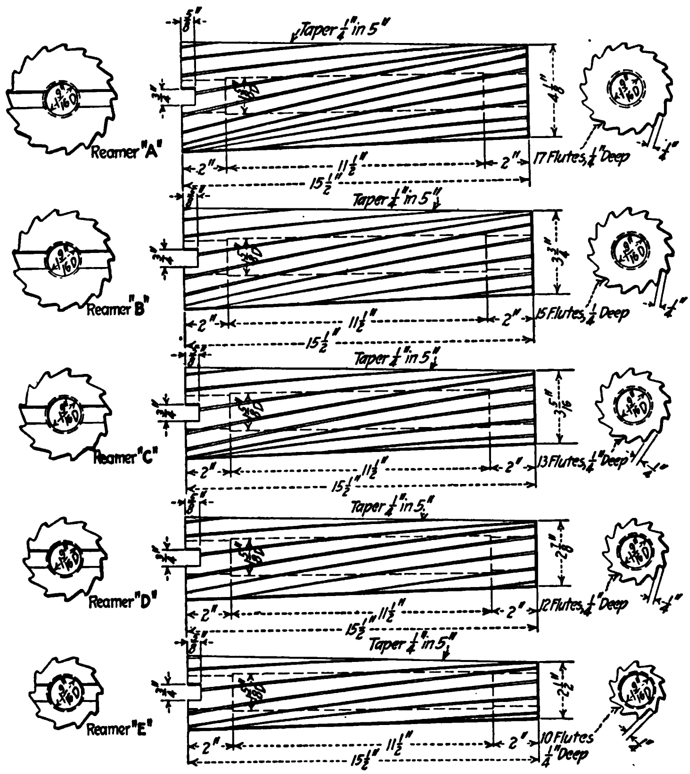
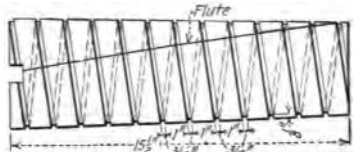


Fig. 74.—Taper crosshead reamers.

The reamers are made independent of the shanks, Fig. 76. The body or cylindrical portion of the shank has a diameter of $1\frac{1}{2}$ in. to receive the hollow reamers. There is a cross key formed on the face of the shoulder on the shank and this key enters a notch milled across the end of the reamer so that when the nut at the end is tightened the shank and reamer are held

securely together. The assembled reamer is shown in Fig. 77. The reamers are shown as made at the Sacramento shops of the Southern Pacific Company.

FIG. 75.



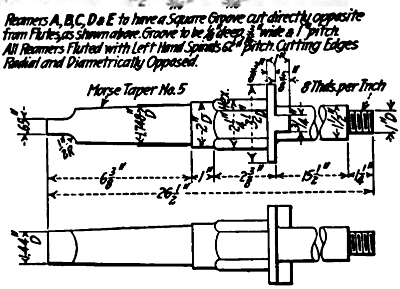


FIG. 76.

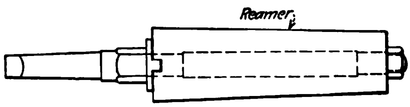


FIG. 77.—Taper reamer details.

PLANING CROSSHEADS

The engraving, Fig. 78, shows a method of planing crossheads for the bearing surfaces. For this operation the rod is located in a pair of V-blocks formed of angle irons with V-clamps at the top. The angle irons are provided with aligning tongues at the bottom to fit into the platen slots and this method of locating the work on the planer table assures the planing of the guide bearings exactly in line with the piston rod.

A planing tool is shown in Fig. 79 which is so made as to cut on each of the three faces of the crosshead bearing surface without resetting the tool in the holder. This sketch gives sections of the tool to show the form of the cutting lips.

The tool is finished with care to secure square corners and is used effectively in planing the crosshead bearing surfaces

smoothly and accurately. It is fed down one side of the work, then down the other and across. It maintains a square corner without requiring rapping first to one side then to the other.

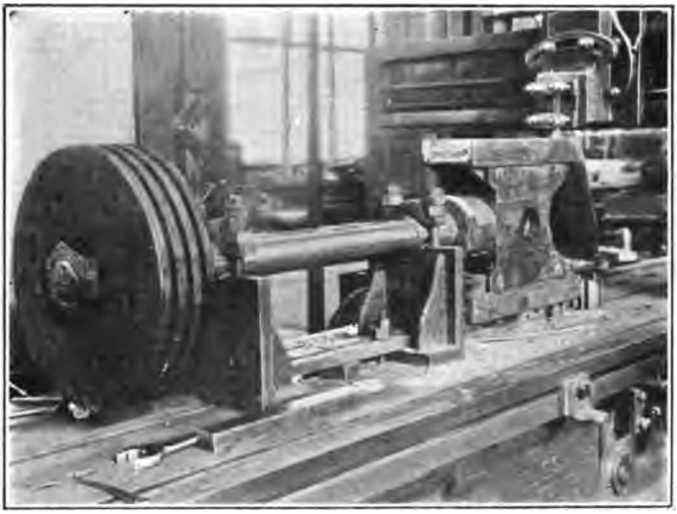


Fig. 78.—Fixtures for planing shoeseats in crossheads.

It is made from stock ½ in. thick, and is secured by two screws to a seat formed in a holder made from rectangular stock of suitable dimensions.

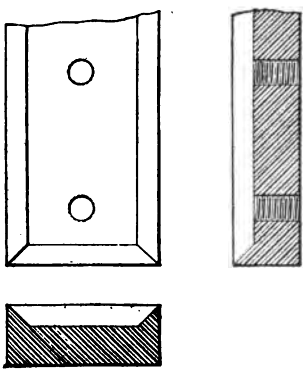


Fig. 79.—Plan and section of planer tool for crossheads.

GUIDES AND YOKE

The form and dimensions of a typical pair of crosshead guides and yoke are illustrated in the line drawing, Fig. 80. Figures

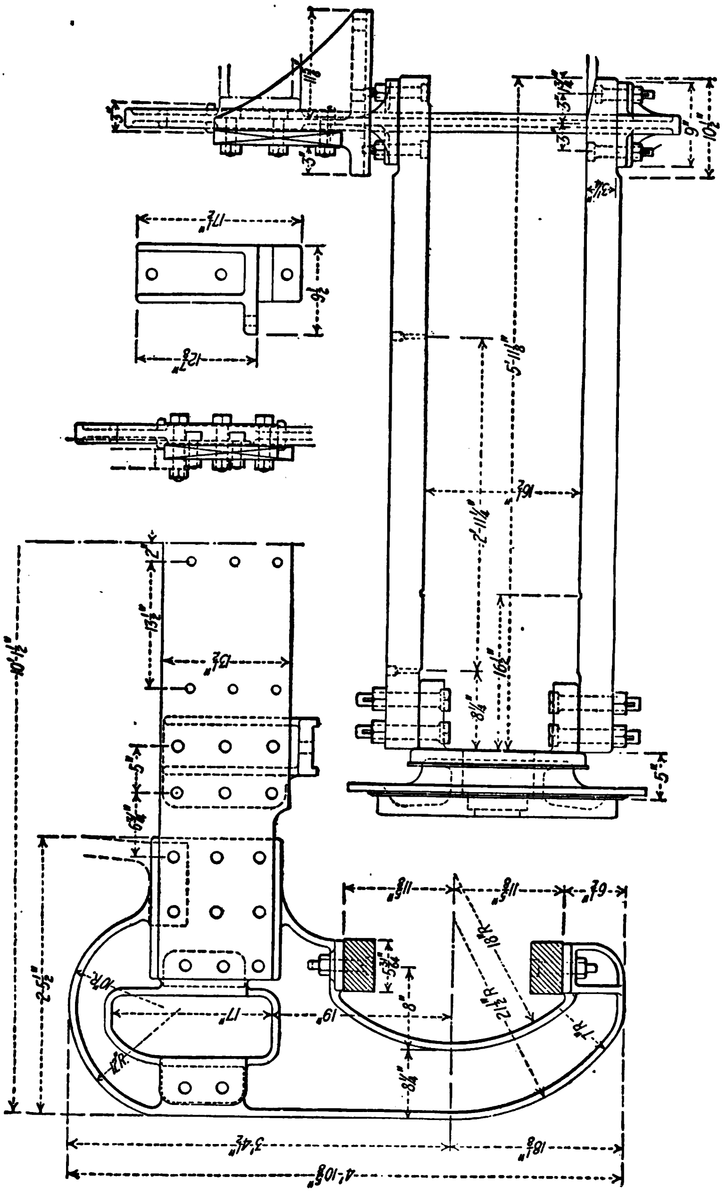


FIG. 80.—Details of locomotive crosshead guides and yoke.

81 and 82 show some operations at the Sparks shops in machining the guides. These guides are of open-hearth steel and are 70⅛

FIG. 81.—Shaping ends of crosshead guides.

in. long, or practically 6 ft. from end to end. In section they are about 5½ by 3¾ in.

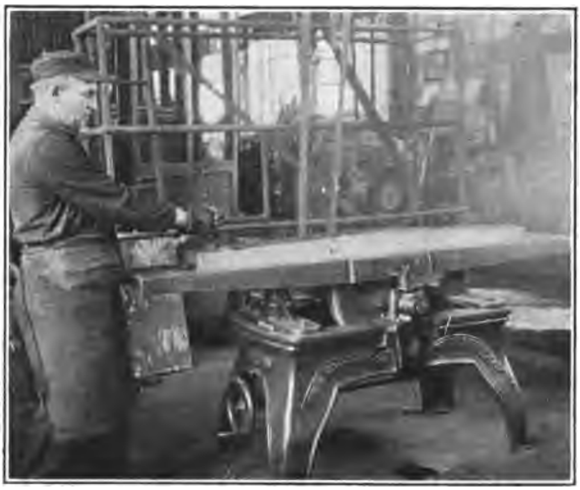


FIG. 82.—Grinding crosshead guides.

The seats at the ends for yoke and cylinder-head connections are formed in the shaper with the guide held in the vise in the

manner shown in Fig. 81. The body of the guide is finished by grinding on the machine illustrated in Fig. 82. This is a surface grinder with the wheel operating below the table, but with the top of its arc just passing up clear through the upper face of the work table. As the wheel wears the table may be adjusted to maintain the cut on the work; and the depth of cut is of course varied at any moment, as required, by adjustment of the table-controlling device. The guide to be ground is drawn back and forth across the wheel top by means of a handle placed in one of the stud holes in the end of the work.

Fig. 83.—Machining yoke in draw-cut shaper.

Where a guide comes into the shop for overhauling with the working surfaces badly worn, the first operation is to plane it down smooth and square. Then it is placed on the grinder for finishing. In cases where the guide is not badly worn, it is sent immediately to the grinder for resurfacing without preliminary operations on the planer. This process of grinding leaves the guide surfaces in excellent condition for the operation of the crosshead and the work of grinding is accomplished economically and effectively.

The machining of a yoke by means of the draw-cut shaper is illustrated by Fig. 83. The work rests with its broad end upon

the table of the machine but the upper end is suported upon suitable jacks and blocks to hold it properly for the planing cuts across its face. The bearing surfaces to receive the ends of the guides are planed out on the same machine, the work then being set up to bring the surfaces to be planed into position parallel along their length with the shaper ram.

ALIGNING GUIDES

The process of aligning guides as carried on in another Western shop is illustrated in Figs. 84 and 85. Here the guide for a single-

FIG. 84.—Setting guides by a line.

bar crosshead is shown attached at its front end to the cylinder casting while the rear end is supported by a bracket. A bent rod of 3/8-in. stock is secured between the washer and nut on the end of the crank pin in the driving wheel, and this is set with its extended arm central with the driver axle, so that a fine thread or wire attached to the right-angle bend may be passed through to the front end of the cylinder to serve as an aligning medium for the setting of the crosshead guide.

At the front end of the cylinder is inserted a piece of wood, bearing at its center a piece of tin, through which a minute hole

is pierced to receive the front end of the aligning thread. This piece of wood is fitted snugly across the counterbore of the cylinder. The small hole in the tin is located at the center of the counterbore in the usual way by means of dividers or trammels. The thread, passing through the stuffing box at the rear end of the cylinder to the bent rod on the driver wheel, establishes

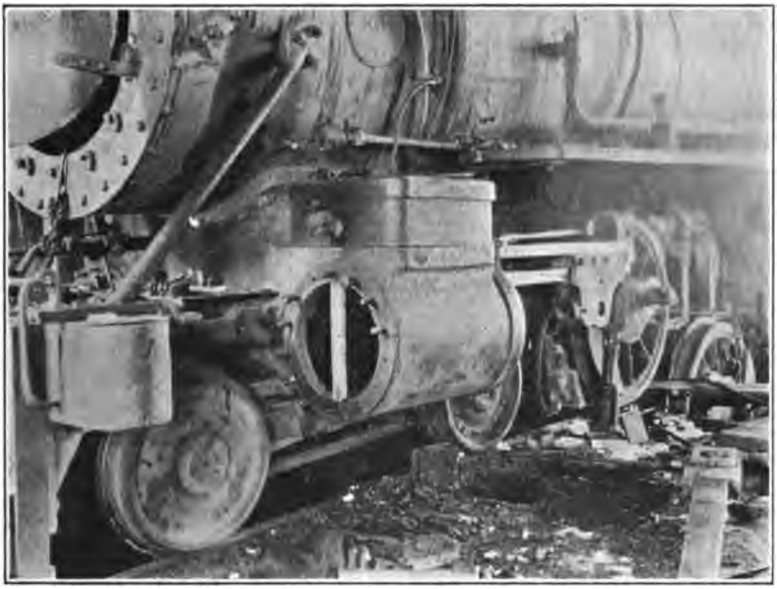


FIG. 85.—Method of setting line at front end of cylinder.

an extension of the center line of the cylinder intersecting the center line of the main driving axle. As this line also passes through the crosshead, it provides a point of departure for the adjustment of the crosshead guide until that member is parallel to the center line of the cylinder and at the right height throughout its length.

CHAPTER VI

CONNECTING-ROD OPERATIONS

The first illustration in this chapter, Fig. 86, represents the side view of a locomotive and brings out clearly the design of the connecting rods, including main and side rods. The line drawing, Fig. 87, gives all details of a set of rods of this design. The half-tone engravings which follow illustrate various operations in the machining and fitting up of main and side rods.

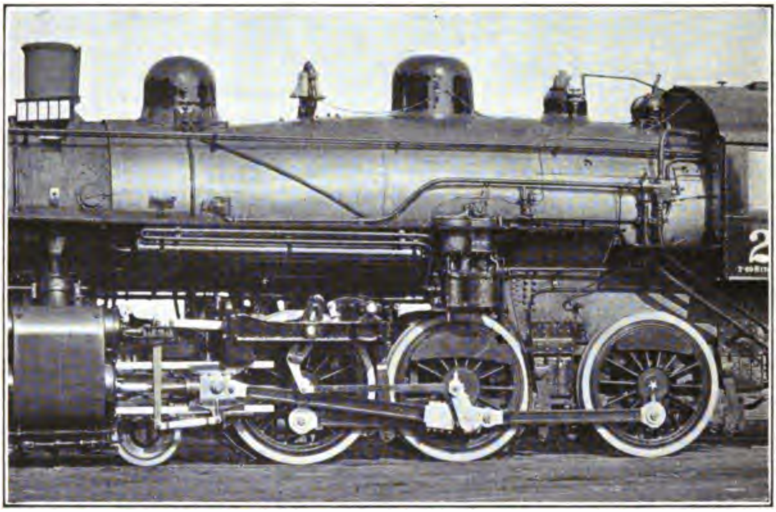


FIG. 86.—Side rods of locomotive, built at Sacramento Shops.

In Fig. 88 the main rod with its external surfaces already milled is shown under the drill press where the front end is being drilled out. The end of the rod when drilled is shown in Fig. 89, as it appears when ready for machining out for the brasses. After the metal has been cut out the opening is machined to size for the brasses. One method of machining this is illustrated by Fig. 90 where a spiral end mill is shown in the vertical spindle milling machine for operating in the rod end. The rod is securely strapped to the table of the miller and further held against movement by rigid jaws clamped

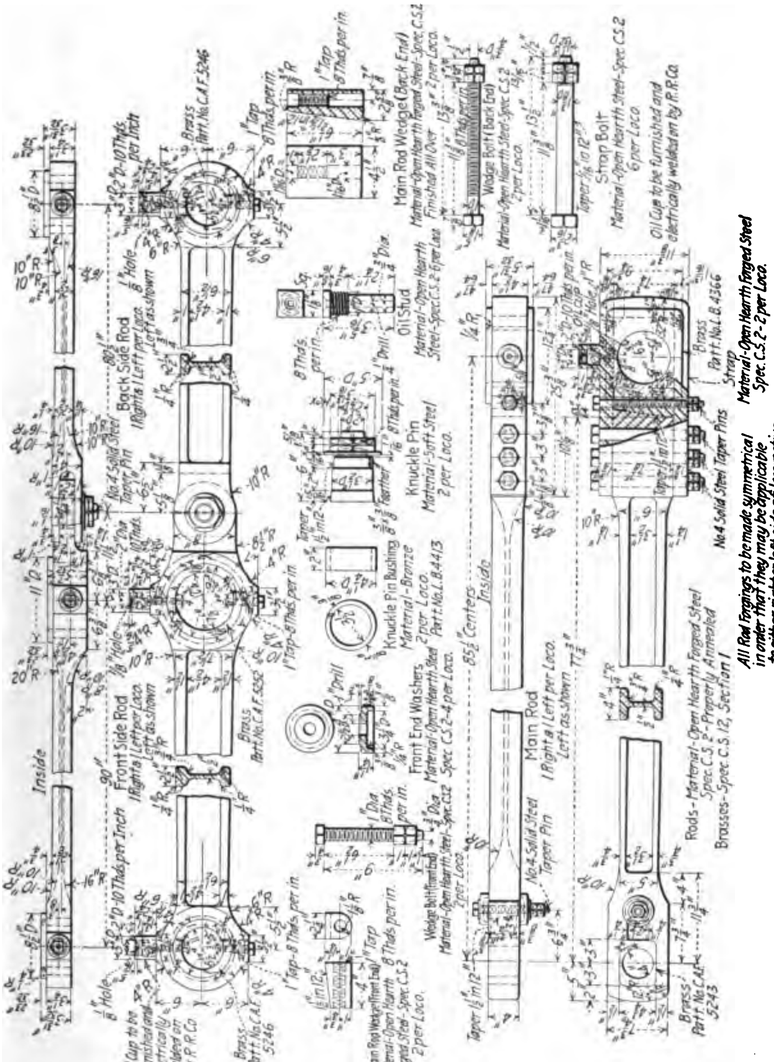


FIG. 87.—Connecting rod details.

at the sides. The rod is 4 in. thick and the cutter 2 in. in diameter, which is the largest size of mill that can be used in the seat for the main rod wedge at this end. The cutter is made with coarse

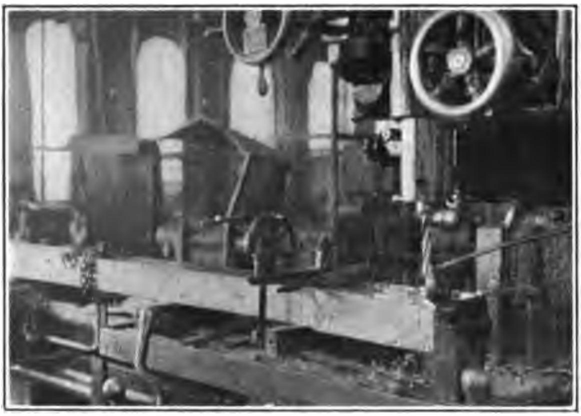


FIG. 88.—Drilling end of main rod.

teeth giving a strong tooth section and providing for liberal chip space. Naturally this cutter with its 4-in. width of cut cannot be crowded unduly, but its advantages over the more common mill with finer pitched teeth are quite evident to the observer.

FIG. 89.—Main rods with ends drilled to block out opening.

CHANNELING CUTS

The forming of the channels along the sides of the main rod to proper width and depth is accomplished on a horizontal milling machine as shown in Fig. 91. On the size of rod illustrated, the channels in the sides are cut 3½ in. wide by 1¾ in. deep, leav-

ing $\frac{1}{2}$ in. thickness of metal in the web at the center of the rod section. A coarse pitch cutter 7 in. in diameter is used on the hori-

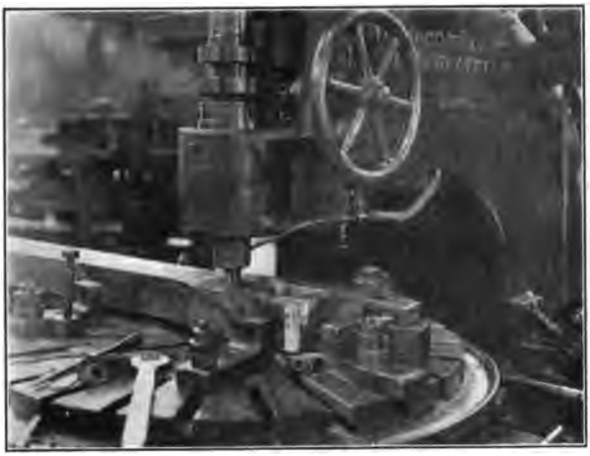


FIG. 90.—Milling out rod end with end mill.

zontal spindle of the milling machine, the width of the cutter being 2 in. Two cuts are taken with this mill to bring the channel

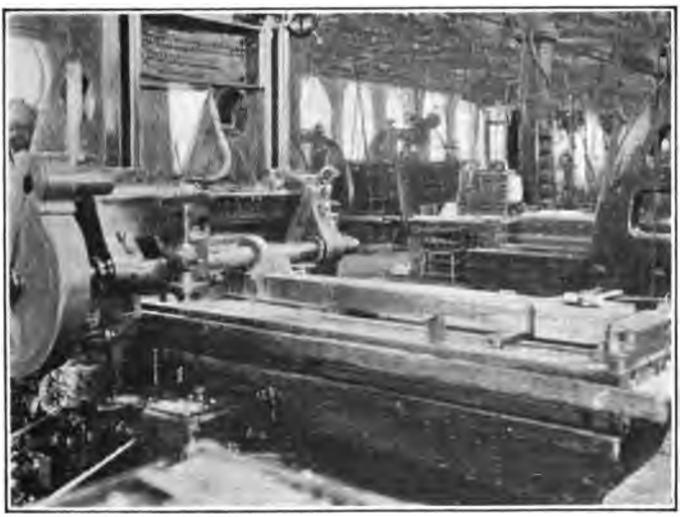


FIG. 91.—Making channeling cuts in rods on milling machine.

to width and these cuts are taken full depth, or $1\frac{3}{4}$ in. The length of the cut is about 60 in.

In making this channeling cut, the cutter arbor is operated at 50 r.p.m., which means a surface speed for the cutter of 84 ft. per minute. The rate of longitudinal feed given the work to the cutter is 2 in. per minute.

OPERATIONS ON BRASSES

The operation in Fig. 92 is the boring out of the brass for the front end of the main rod which is attended to after the brass and wedge have been fitted in place. For this machine operation a single point boring tool is applied in a short, solid bar car-

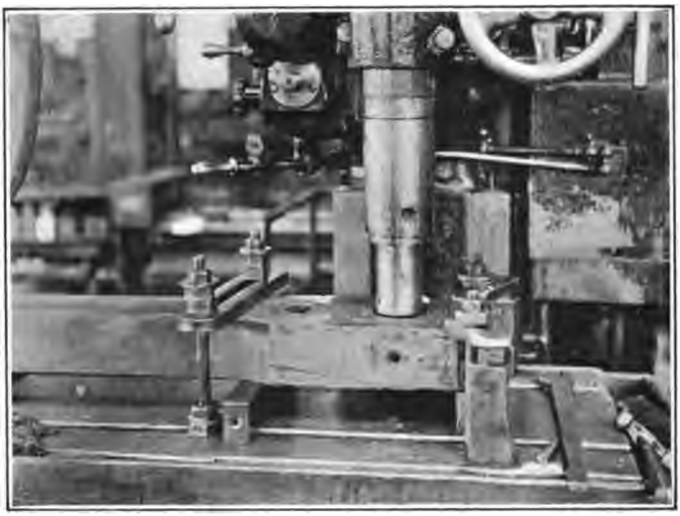


FIG. 92.—Boring out rod brass under drill press.

ried in the heavy drill spindle, and this bores out the bearing in the brass to the desired diameter.

The machining of the flanged brasses for the back end or strap end of the main rod is illustrated in Figs. 93 and 94. The first of these views shows the shaping of the sides of the brasses with the work held in the vise on the shaper table. In this operation a transparent guard in a metal frame is carried by the tool post so that the brass chips are prevented from flying and at the same time the machinist can watch the work freely. The draw-cut shaper in Fig. 94 is shown in the operation of machining the flanged edges and bearing surfaces around the four sides of the

brass. Here the work is again secured in the shaper vise, but this time in upright position.

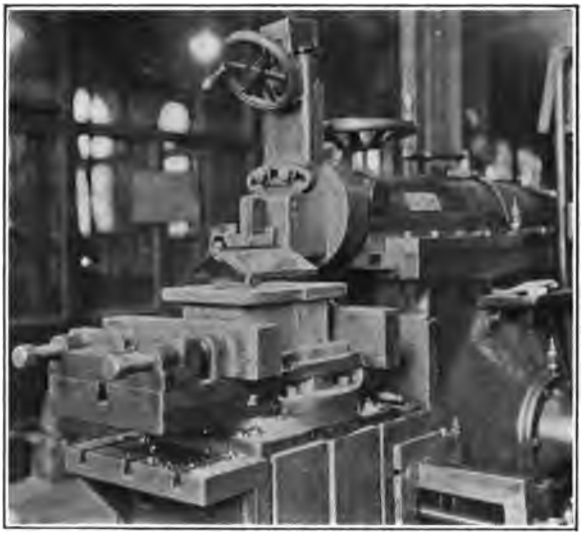


FIG. 93.—Machining sides of brass in shaper.

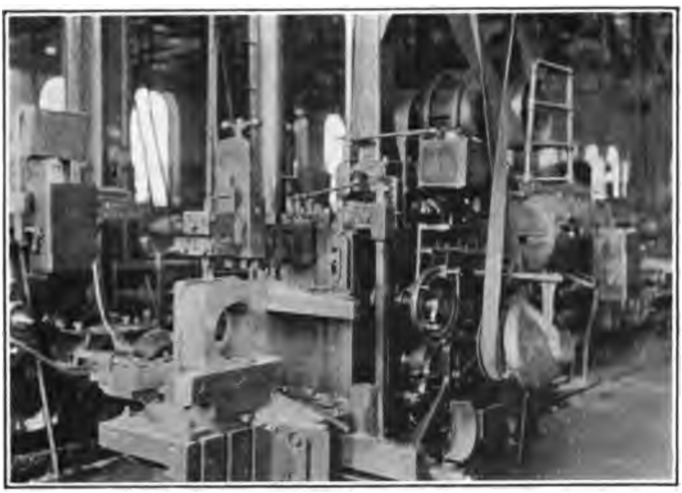


FIG. 94.—Draw-cut shaper in operation on edges of brasses.

The views in the rod shop, Figs. 95 and 96, show a number of main and side rods, and various brasses ready for fitting as well

as some already in place in the straps. The bench view at the rear of Fig. 95 shows the fitting up of brasses in their straps.

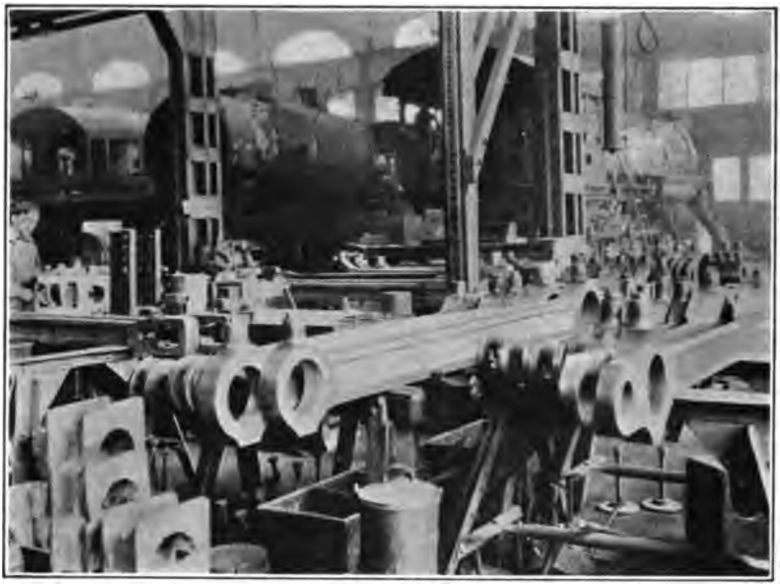


FIG. 95.—View in rod department.

FIG. 96.—Rods, straps, and brasses ready for fitting up.

Two different ways of boring the main rod back end brasses are represented in Figs. 97 and 98. In the first method the work is

held in the strap with the latter mounted upon parallels on the table of the vertical boring mill. The other method, illustrated in Fig. 98, is to secure the strap and brass in the four-jawed chuck

FIG. 97.—Boring rod brasses on the vertical mill.

of a big lathe and bore the brass with a heavy bar carried on the tool slide of the lathe.

FIG. 98.—Boring rod brasses on the lathe face plate.

MILLING SIDE RODS

The milling of a side rod forging is shown by Figs. 99 and 100. In the first, is represented the slabbing of the heavy cuts from the

broad side of the forging as accomplished on the horizontal milling machine with a large inserted tooth cutter shown clearly in place

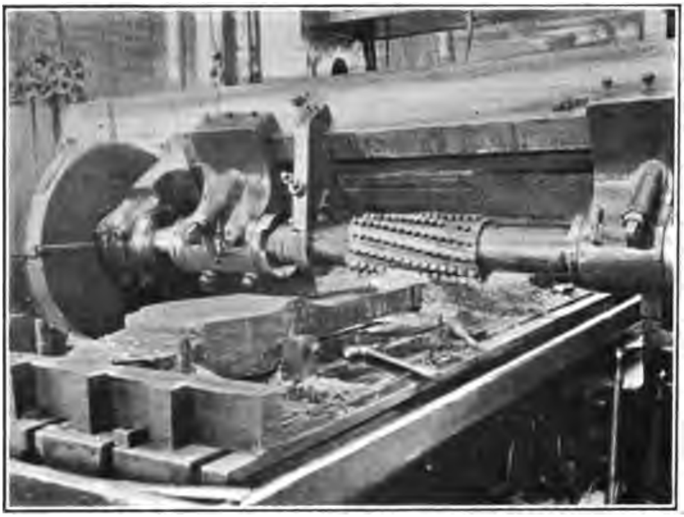


FIG. 99.—Milling flat side of side rod.

on the mandrel of the machine. This cutter is over 22 in. across the face and 10½ in. in diameter. It is fitted with 12 rows of

FIG. 100.—Slab milling edges of two side rods.

1-in. high-speed steel teeth inserted in spiral lines across the face of the cutter body. In taking the cut shown in Fig. 99 the cutter

is rotated at 22 turns per minute, or at a surface speed of 66 ft. per minute. The rate of feed is 1½ in. per minute. The depth of metal removed from the side of the forging in the one cut is ⅜ in.

The edges of these side rods are milled in the manner shown in Fig. 100. In this case there are two of the large inserted tooth cutters set up on the machine spindle, each cutter being adapted for milling the edges of two side-rod forgings at once. Thus four forgings can be edged at one setting, although this view actually shows only two, both of which are being machined under the further cutter.

FIG. 101.—Milling the round end of the rod.

The metal to be removed from the rod edges ranges from ⅜ to ½ in. until the large end is approached when the stock milled away is 2 in. or more in depth for a distance of a few inches. The feed of the work to the cutter is 2 in. per minute. The speed of cutter rotation is the same as with the slabbing operation in Fig. 99, or 22 r.p.m.

The rounded ends of front and back side rods are machined to the desired radius by mounting the work upon a rotary table on the vertical spindle-milling machine as in Fig. 101, and using a large end mill or shank mill to operate upon the rod. The cutter here shown is 5 in. in diameter and is made with coarse pitch,

spiral teeth. At the heaviest part of the forging there is a breadth of cut of 4 in. and the metal to be removed ranges from $\frac{3}{8}$ to $\frac{5}{8}$ in. on a side. One cut only is taken. The cutter is driven at a rate of 30 r.p.m. giving it a surface speed of 45 ft. per minute. The rate of feed for the work is 2 in. per minute during the milling of the circular end of the work, but this is proportionately increased while operating along the straight sides of the rod.

The milling out of the forked end of the back side rod is accomplished in this shop[1] with the work carried upon the table

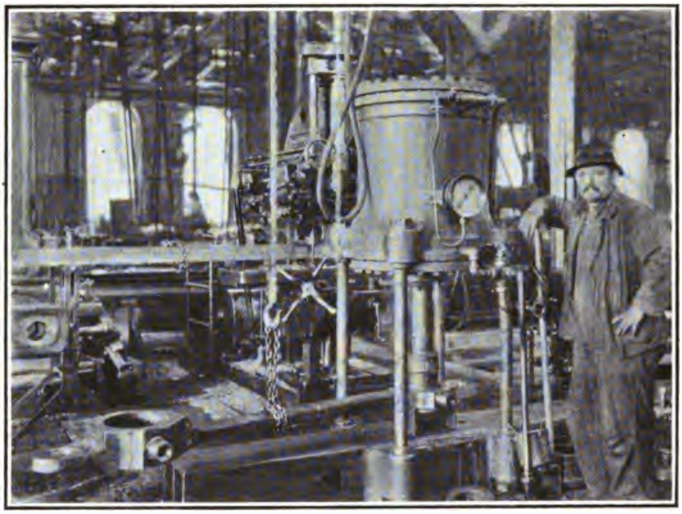


FIG. 102.—Forcing the brass into the front side rod.

of the horizontal miller while a 2-in. spiral cutter is fed into the forging. This cutter is 9 or 10 in. long in order to reach across the widest portion of the rod end which measures 8 in. across the forging.

OTHER OPERATIONS

In Fig. 102 a front side rod is shown under the pneumatic press for the forcing in of the brass. In Fig. 103 the same press is seen in the operation of straightening a rear side rod. The method of supporting the rod under the ram and the general handling of the work will be apparent from the engravings.

The rod in Fig. 104 is of somewhat different design but the

[1] The work and methods in this chapter up to Fig. 106 are from the Southern Pacific shops at Sacramento.

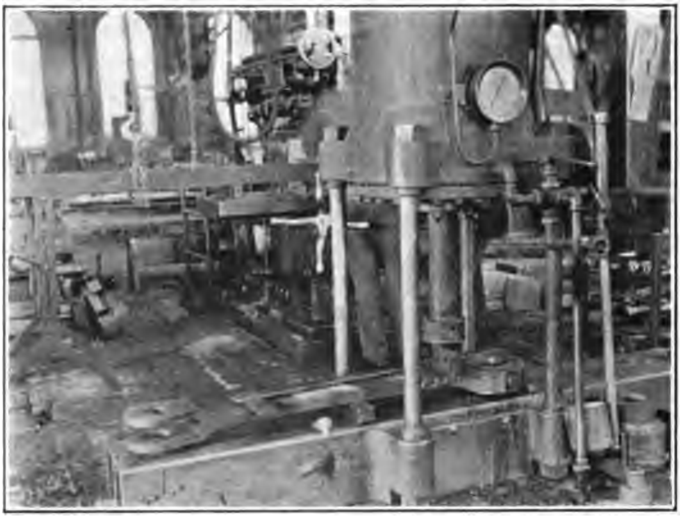


Fig. 103.—Straightening a bent rod.

Fig. 104.—Drilling oiler hole in rod.

general method of milling corresponds to that followed with the strap end rod already referred to. Here the rod is shown undergoing the drilling for the oil cup and a neat method of supporting the outer end of the work will be seen in the photograph. The metal support at the left is adjustable for height and is thus a convenience when levelling work on the machine table.

The racks in Fig. 105 are another convenience. They are made up of A-shaped frames with projecting arms of channel irons and each arm has sufficient length to receive several side rods.

Fig. 105.—Racks for holding side rods.

METHODS IN OTHER SHOPS

The vertical slotting machine is of course used extensively in railroad shops and in some places the slotter is kept busy most of the time on rod work. Thus in Fig. 106 it is seen engaged in the operation of machining out the solid end of the main rod, whose projecting outer end is here supported upon a horse or trestle as indicated. The slotter tool is forged up as stiffly as feasible and the cutting edge is ground to a form best adapted to enable the opening for brass and wedge to be machined advantageously.

The cold saw cutting-off machine has long been used for cutting out the stock between crank shaft webs and it may be used to equal advantage in sawing out the metal in the ends of connecting rods. Holes are first drilled at the back of the portion to be

sawed out and these limit the distance to which the saws are run into the rod end.

A method of milling out the fork ends of side rods with a large inserted tooth cutter has been carried out satisfactorily by handling the job in the lathe as no milling machine was open at the time. The work is secured to the face of a heavy angle plate on the carriage and the cutter carried on an arbor between the faceplate and tailstock. The cutter is 18 in. in diameter and has inserted teeth of high-speed steel. The arbor on which it is mounted has a large flange at one end which is turned true and fitted in a shallow recess in the faceplate. Several bolts are used to secure the arbor flange to the faceplate and a stiff drive is obtained in this manner without vibration between faceplate and cutter arbor. The cutter is run into the solid end of the rod to cut out the fork opening D and is then used on the outside of the rod to surface the faces E, Fig. 107. Before the rod is mounted upon the lathe fixture a hole is drilled through the rod edgewise to form a round hole F for the end of the slot and provide clearance space for the milling cutter to run into.

Fig. 106.—Slotting out the end of a main rod.

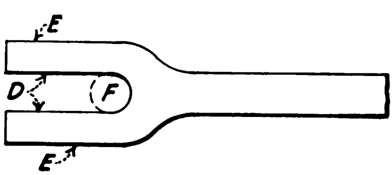


Fig. 107.—Rod end with fork milled out.

BORING ROD ENDS

The boring of rod ends is accomplished at some shops, with a hollow cutter in the drill press. This cutter has two teeth and is a piloted hollow mill. It cuts out an annular channel of the right diameter and thus removes the bulk of the metal in the form of a core. A good-sized opening is first bored through the work to receive the pilot on the tool and this allows the operation to be carried on without chatter or deflection of the tool. Its blades are of stiff section and it is ground to cut freely.

A method seen at the Santa Fe shops in San Bernardino, Cal. for boring side rod bushings makes use of the horizontal-boring machine with the side rod strapped against an angle plate. The bar is supported in the outboard bearing and flat cutters may be used for both boring and facing if required.

MACHINING ROD BRASSES

Where rod brasses are put through the shop in considerable numbers it is always possible to make simple planing fixtures for holding a dozen or more in a string and planing them all at one time. Sometimes a number are placed on the table of the milling machine and faced on the different sides, several in a row.

A method of milling the strap fit on rod brasses at the shops just referred to involves the use of the horizontal miller with the work strapped, several brasses at a time, against the face of an angle plate fixture. The cutters are spaced the desired distance apart to give the cut the proper width, by means of an adjustable threaded collar placed between them on the arbor.

Various fixtures are in use for machining brasses one at a time as is commonly done in many repair shops where few duplicate parts go through the shop at one time. One method of doing such work is to make use of a circular table on the milling machine. An end mill is used and the brasses are indexed around by the rotary table to bring one face after another into position for surfacing.

A shaper fixture for brasses is seen in Fig. 108 as photographed in the M. K. & T. shops at Parsons, Kan. This fixture is provided with an index plate for locating the work correctly in the different positions required in finishing the bearing surfaces around the edges. When the brass is secured to the spindle of the fixture and the index locked, the adjustable wedge is set up

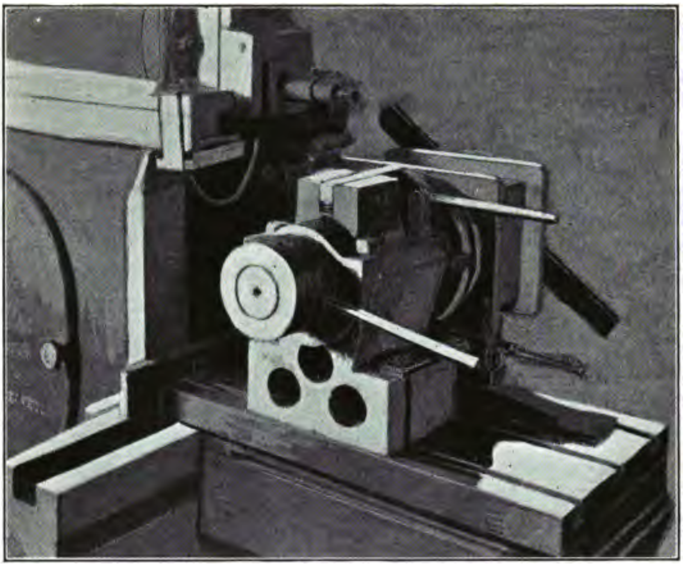


FIG. 108.—An indexing fixture on the shaper for rod brasses.

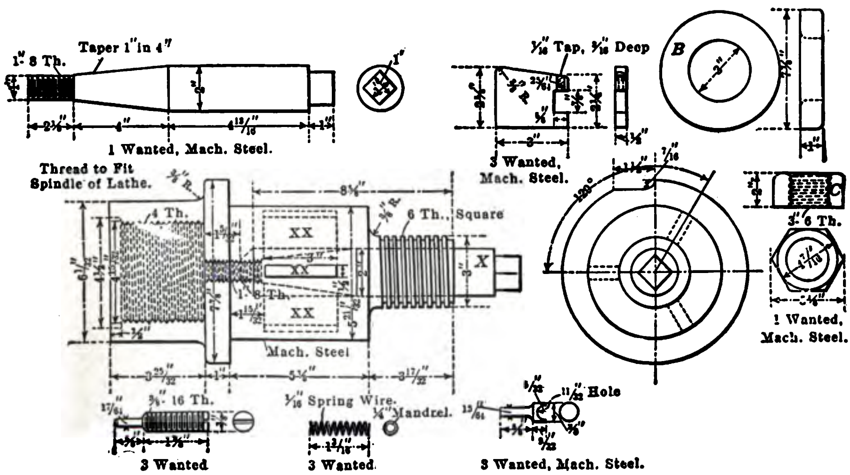


FIG. 109.—Expanding mandrel for rod brasses.

under the work to hold it rigid during the cut. The wedge has a quick adjustment along the serrated block at the bottom, and after it is pushed up the incline into contact with the brass, the adjusting screw is turned to bring it snugly to place. It is a simple matter as fast as each side of the work is finished, to withdraw the wedge, release the index and set the brass for the shaping of the next face.

EXPANDING MANDREL FOR SOLID BRASSES

The line engraving, Fig. 109, shows an expanding mandrel designed by Chas. Markel for use in turning up solid side rod brasses. This mandrel is threaded to screw on the lathe spindle, which makes the drive very rigid and steady. To use the mandrel the brass is first bored to size and is then faced to width. It is then placed on the mandrel and by screwing up the plug marked *X* (it being tapered on the other end) it forces out the three dogs *XX* and thus the bushing is centered perfectly. The washer *B* is then applied and power applied to nut *C*, which drives the bushing against the cut. The springs shown are to hold the dogs down against the taper on the plug.

CHAPTER VII

MAKING DRIVING BOXES

Although driving box work is handled in practically all of our railroad shops, it forms an interesting line of operations for the reason that there are so many different methods employed in the carrying through of the work. The planing of the boxes themselves, the shaping, slotting or turning of the brasses, the fitting of the brasses into the boxes, the pouring of the lateral bearings and side liners, the finishing of the journal and side bearings are all items which are dealt with according to the equipment and requirements of the shop doing the work. Where large numbers of boxes are constantly passing through the shops, a certain line of machine tool and special equipment is kept busy on this one detail alone. Where, on the other hand, driving boxes are only an occasional item of replacement for a small shop or roundhouse, it is naturally the case that the general methods of handling the operations will differ appreciably from those of the big plant.

In the present chapter, views are reproduced from a number of different railroad shops, showing the important features pertaining to driving box work in both large and small places. The illustrations that immediately follow, that is Figs. 144 to 158 inclusive, are from one of the largest of our railroad plants.

A TYPICAL BOX

The line drawing, Fig. 110, illustrates a heavy 10 by 12-in. driving box used on various classes of locomotives. It is of cast steel with heavy brass pressed into place for the axle bearing and with brass liners on the sides of the box for the bearing surfaces between shoes and wedges. The end of the box is babbitted to provide a thrust or lateral bearing surface. The brass liners at the sides, like the babbit lateral bearing, are formed by pouring the molten metal into place and, afterward, finishing to required dimensions. The liner metal is anchored by pouring it into

dovetailed grooves formed at an angle to the vertical center line of the box, and the babbit thrust bearing is similarly anchored by dovetailed annular channels and plugs in the face of the cast-steel box. Details of these features are clearly shown on the drawing.

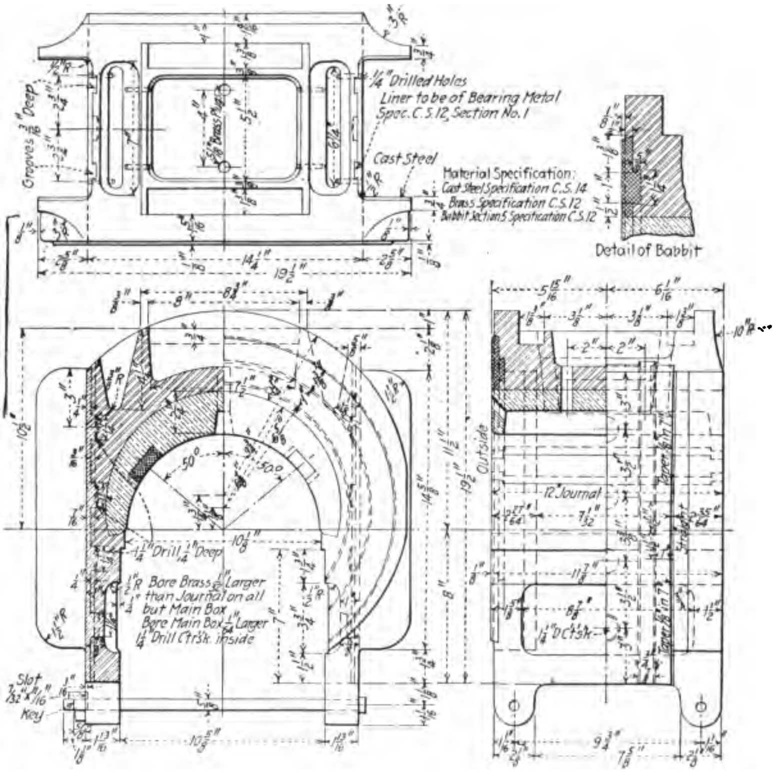


FIG. 110.—Driving box.

MACHINING THE BOX TO RECEIVE THE BRASS

Of the various steps to be considered in the machining of this box, the first to be illustrated is the planing out of the interior as in Fig. 111 to receive the brass. This engraving shows a pair of these driving boxes set up in the chuck on a Morton draw-cut shaper where the inside of the jaws is planed out and the circular seat planed to receive the brass. The proportions of the work are well illustrated by this engraving. The surface machined out

is to receive a brass shell $2\frac{1}{4}$ in. thick. The face of the box is machined for a babbit lining which when finished will be $\frac{3}{8}$ in. thick.

The method of holding the two boxes on the draw-cut shaper is sufficiently clear from the illustration. The type of machine here used lends itself admirable to the work of this class. Its ram reaching forward through the casting and cutting on the return stroke permits of a heavy feed and deep cuts without chatter and without springing of the tool away from the surface of the work. As shown here, the cutting tool is removing the metal with a

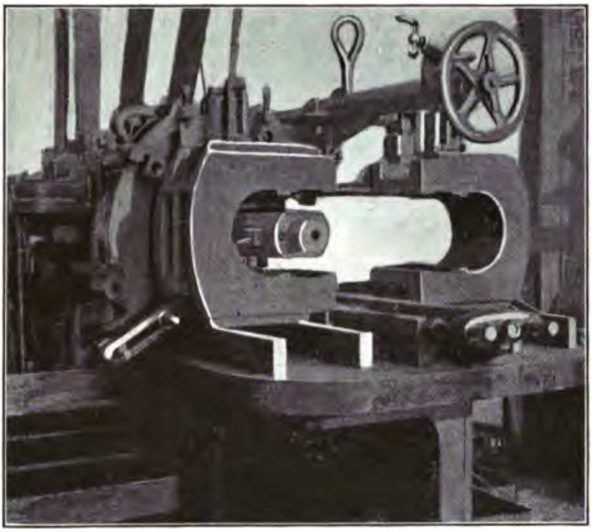


FIG. 111.—Planning driving boxes on a draw-cut shaper.

depth of cut of about $\frac{1}{2}$ in. and a feed of $\frac{3}{32}$ to $\frac{1}{8}$ in. per stroke of ram, which means a very reasonable length of time for completing the semi-circular seat for the brass. Running say, at 15 complete forward and return strokes per minute, the actual rate of operation under a 3 to 1 ratio for the non-cutting stroke would work out at 25 ft. per minute.

PLANING THE BRASSES

The methods followed in shaping the outside of the brasses on the type of machine are illustrated by Figs. 112 and 113. Here the work is shown mounted between fixtures on a rotary

chuck which turns automatically the amount of the desired feed upon the completion of each stroke of the shaper ram. Figure 112 shows the convenient method of picking up the work with

FIG. 112.—Setting driving box brass in draw-cut shaper.

the sling and hoist to place it in the fixture and the next engraving represents the planing operation nearing completion. The

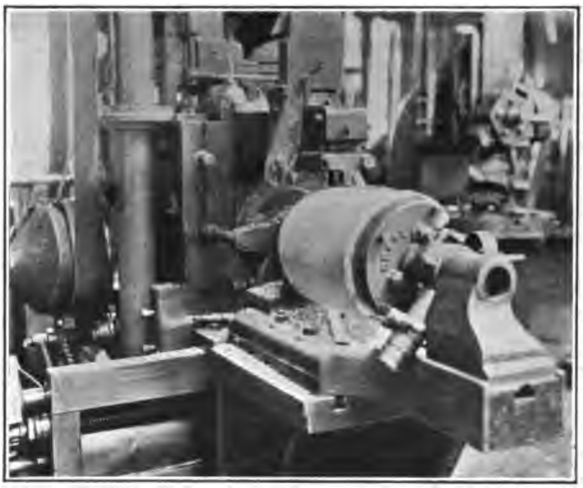


FIG. 113.—Planing the brass.

shaper is operated at the rate of 20 complete strokes per minute with a feed of $\frac{3}{16}$ in. and a depth of cut ranging from $\frac{1}{4}$ to $\frac{3}{8}$ in. So the finishing of the external surface requires only a few

moments and the setting and removal of the work causes but a brief delay between successive brasses.

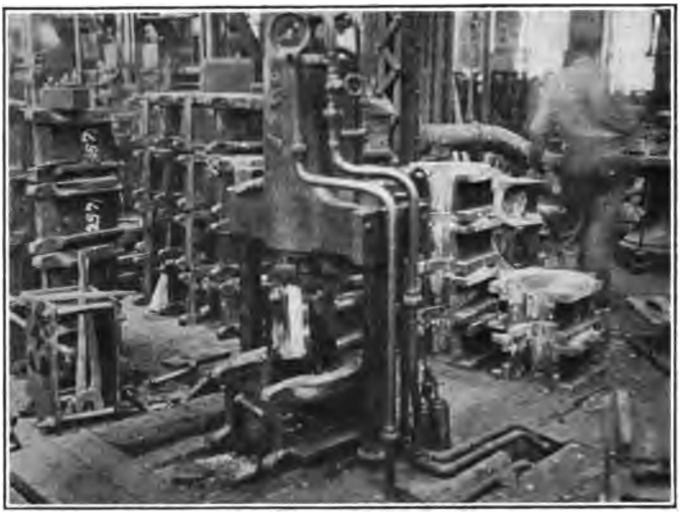


Fig. 114.—Press for forcing brasses into driving boxes.

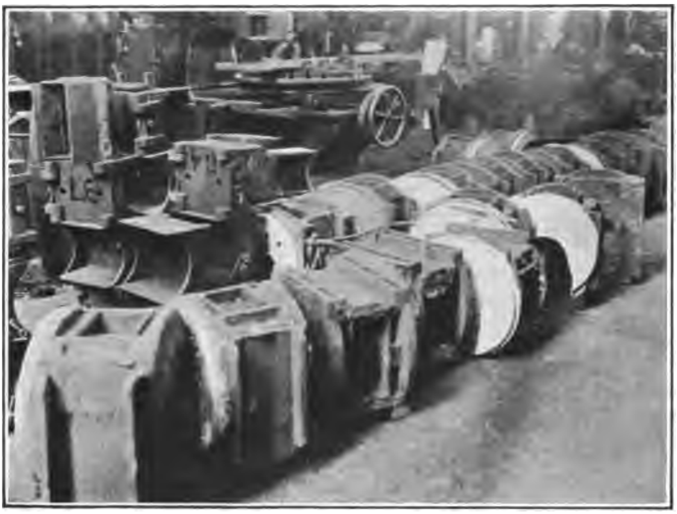


Fig. 115.—Boxes and hooks for slinging from crane.

The press used for forcing the brasses into the boxes is shown in Fig. 114 with a brass just entered in the chamber in the box ready

for pressing into place. This press stands close to the boring and facing machines and is also adjacent to the planers where the sides and ends of the boxes are machined. Work is handled between the press and machines by means of the sling hooks seen on the row of boxes in Fig. 115, this pair of hooks being used on a convenient hoist.

A PLANING FIXTURE

The sides of the boxes are planed as illustrated by Fig. 116, with two rows of boxes secured to a long fixture on the planer

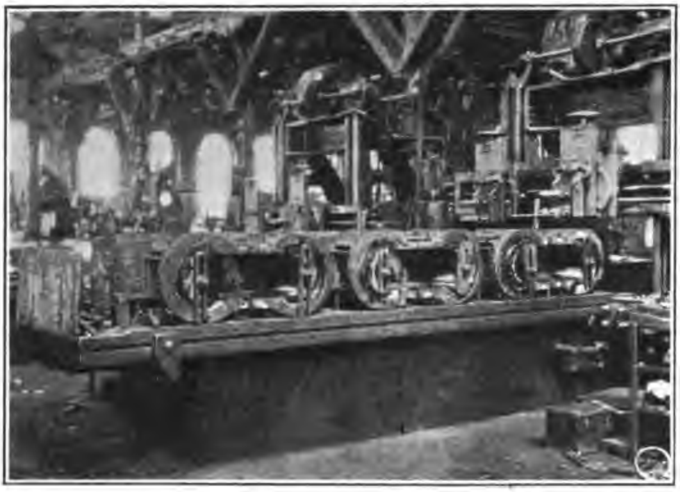


Fig. 116.—Planing a string of boxes at one setting.

table, so that the whole length of the platen is filled with boxes and allowing both planer heads to be used. The fixture is a long-cored casting, a hollow box-like structure, with its outer faces machined to receive the driving boxes for planing. Long through-bolts and straps are provided and these are used to bolt the boxes snugly to the two sides of the fixture. The boxes are placed as represented, two by two, with open jaws facing each other so that in addition to the straps for securing the work to the fixture, other straps are placed between each pair of boxes to draw them firmly down to the surface of the platen.

It will be understood that before the side planing of the boxes and the boring of the brasses are attended to, the pouring of the side liners and babbit side or lateral bearings has to be done.

These babbitting operations, however, will be described a little later. The planing and boring operations as accomplished at this shop will be covered first. The tops of the boxes are finished on the draw-cut shaper as illustrated by Fig. 117, where a single box is set up, as represented, against an upright surface on the knee carried by the machine. The method of strapping and clamping to knee and table is brought out clearly in the engraving.

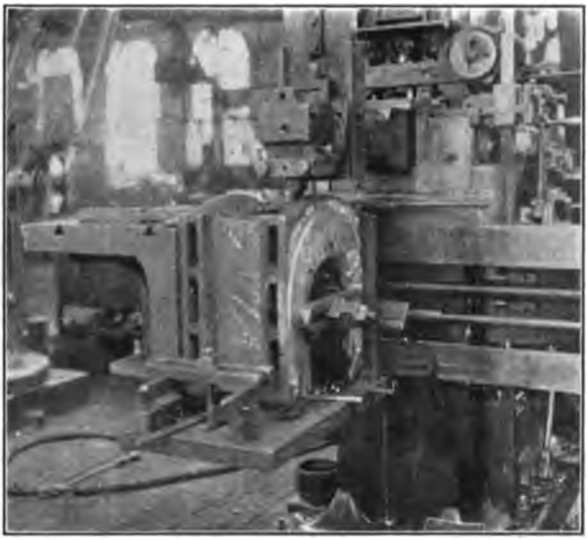


FIG. 117.—Planing end of box in draw-cut shaper.

BORING AND FACING OPERATIONS

The boring of the brass and the facing off of the babbitted surface are operations which are accomplished at this shop in a double-spindle machine. In this machine two boxes are finished simultaneously, the spindles being set in this instance at opposite ends of the crossrail. The boxes are gripped in the broad-faced chuck jaws and the practice here is to run two boring cuts down through the work.

On this work the spindle and boring cutter are run at 60 r.p.m. for the boring cut, with a rate of feed of $1/32$ in. per revolution. The depth of chip for the first or roughing cut, is from $3/8$ to $1/2$ in. and for the finishing cut $1/32$ in. on a side. The boring tool in operation is shown in Fig. 118, which also shows clearly the

method of chucking the work in the heavy jaws. The head carrying the boring spindle is adjustable along its rail and the chuck for holding the work is adjustable toward front or back so that the proper setting for the position of the boring cut in the brass is readily obtained.

In connection with this boring operation, Fig. 119 is of interest as illustrating one of the many guards used about the shop. The guard shown is of special service on this work owing to the

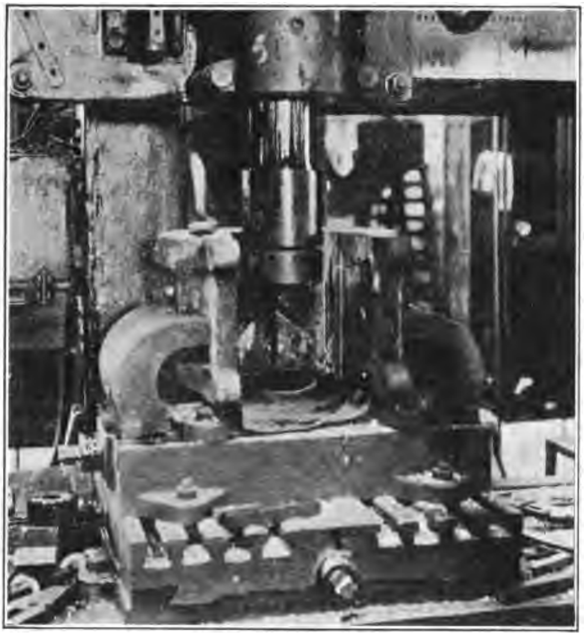


FIG. 118.—Boring the brass.

tendency for the brass chips to fly when removed at a fairly high rate of speed. The guard is in the form of a sheet-metal hood which has at the front a swinging leaf which may be raised for observation of the work and tools. The whole guard may be slipped off of the work in an instant when the boring is completed and as easily applied after the next box is ready for machining.

The long cutter shown in operation in Fig. 120 is used to finish the babbitted face of the box. This cutter sweeps over the face of the work at the same speed as that of the boring tool, or 60 r.p.m. When the face is nearly down to desired thickness the finish on the surface is obtained without chatter by stopping

the spindle, then starting it slowly and letting it make two or three revolutions at slow rate of speed to allow the cutter to

Fig. 119.—Safeguard for preventing chips from flying from the boring tool.

scrape the surface perfectly smooth. The rounding out of the ¼-in. corner is done with the cutter shown in Fig. 121 which

Fig. 120.—Facing the babbitted lateral face of the box.

has a fillet of the desired radius. The speed of operation is the same as for the preceding cut.

Details of the facing and corner-rounding tools are given in Fig. 122*A* and *B*. It will be seen that the facing tool *A* is made fo ¾ by 1¾-in. stock and it has a total length of 16 in. The

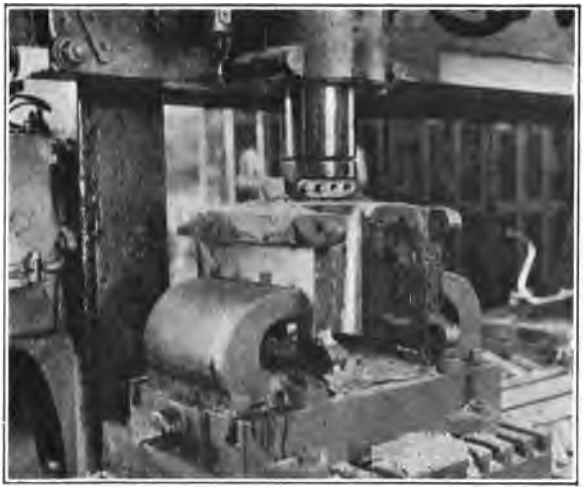


Fig. 121.—Finishing the corner radius.

cutting portion is 10½ in. long and is ground off to a clearance of 2 degrees while a small lip is formed on the cutting face by the concave groove shown. Although the cut taken by this tool is

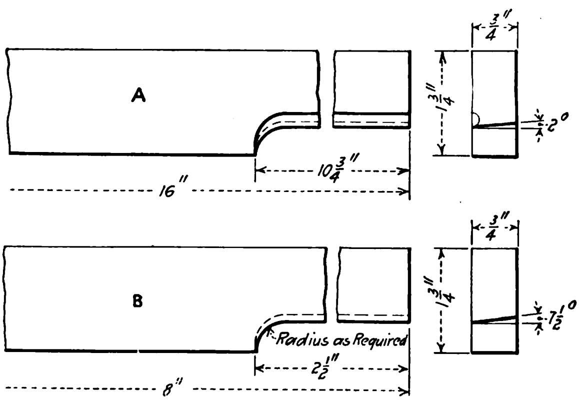


Fig. 122.—Facing tools.

a broad one the form of lip and clearance provide for a clean smooth action. The radius tool *B*, Fig. 122, is of the same size stock as the caing cutter. It is, however, given more clearance

or cutting rake, the angle being 7½ degrees as indicated in the illustration.

BABBITTING OPERATIONS IN ANOTHER SHOP

Reference has already been made to the point in the order of operations where the side liners and babbit lateral faces are

FIG. 123.—Apparatus used for melting babbitt for driving boxes.

poured prior to the external machining of the boxes and the internal finishing of the brasses. These operations will now be illustrated, the engravings which follow being reproductions of photographs taken in another representative shop where boxes

FIG. 124.—The melting furnace and the work.

similar to those described above are regularly handled, both as new work and as items requiring overhauling. Figures 123 and 124 illustrate the equipment developed for the melting and pouring of both brass liners and babbit side bearings, and the

sequence of operations for the babbitting process is shown by Figs. 125, 126 and 127.

Fig. 125.

Fig. 126.

Fig. 127.
Sequence of operations in babbitting driving boxes.

Referring to Fig. 123, it will be seen that the babbitting outfit consists of a pair of melting pots made of heavy boiler plate and

heated by means of fuel oil, the pipe for the oil and the pressure pipe for spraying the liquid fuel being shown at the front of the apparatus. The pouring ladle is fitted with a long wooden handle similar to that for a spade or shovel so that the workman may dip and pour the molten metal conveniently and without danger of burning his hands.

In Fig. 125 a box is represented with the main brass forced into its seat and the box end ready for the placing of the clay dam around the edge and the subsequent pouring of the babbit metal. In Fig. 126 the box is shown with a block secured in the brass to limit the flow of molten metal inward and with clay around the outer edge to confine the metal flowing in that direction. In Fig. 127 the box is shown already poured and ready for the machining of the journal bearing and the babbit thrust. It may be of interest at this point to call further attention to one or two points in connection with the fitting up in this shop of the brass and the forcing of the brass into place; operations which, as has been pointed out, take place, of course, before the pouring of the babbit lateral surface.

A TURNING ARBOR FOR BRASSES

The brass is of heavy section as will be seen upon reference to Fig. 125, or to the line drawing, Fig. 110. As the increase in

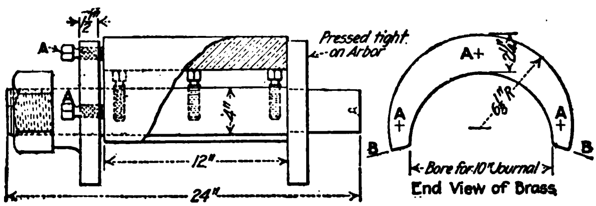


Fig. 128.—Arbor used for turning brasses.

thickness toward the center of the arc of the brass means that the outer circumference is eccentric to the bore, it is obvious that, to turn the outer diameter under these conditions, some form of arbor is essential that will throw the brass off center an amount equal to the eccentricity of the outside surface of the brass which must be turned to size.

The arbor used in this shop for this purpose is sketched in Fig. 128. It is about 4 in. in diameter by 24 in. long and has at one end a tight flange nearly as large in diameter as the outside of

the brass to be turned. At the other end is a similar flange, but easily fitted on the arbor, so that it may be adjusted by means of a nut mounted upon the threaded end of the arbor, as indicated. The latter flange carries three set screws A, for clamping the journal brass endwise against the opposite flange which is pressed upon the end of the arbor. Along the middle of the arbor there are three screws tapped in at right angles to the axis of the arbor to form supports for the work. These screws are adjusted to throw the brass the required distance off center, so that the outside diameter will be turned to the desired degree of eccentricity in respect to the bore of the brass.

Fig. 129.—Pouring side liners.

To insure a snug fit of the brass in its seat in the driving box the outside is turned straight from end to end to a radius 0.003 in. oversize; and the circumferential measurement or distance from B to B is left $\frac{1}{65}$ in. long so that the brass requires about 5 or 6 tons pressure to force it into place in the box. The brass is left long to allow for finishing to length after the babbit has been poured for the lateral-bearing surface. In Figs. 125, 126 and 127 the end of the brass will be noticed projecting above the end of the box.

The brass liners at the sides of the box which form the bearing surfaces in contact with the frame shoes and wedges, are poured in the manner indicated in Fig. 129 which is another view of the melting furnace illustrated in Fig. 124. In Fig. 129 the melting machine is seen in action and a box ready for the pouring of the brass liners will be noticed immediately in front. The furnace is made of an old tank of boiler plate and is operated by oil fuel.

It is suspended upon trunnions at the ends and is readily tilted upon its axis to pour the molten metal through the opening shown in the side. The dovetailed anchor grooves for the liners have already been mentioned and their dimensions and location will be understood from the general drawing, Fig. 110. As there shown, these liners are finished to a thickness of ¼ in. When poured they are, in the rough, approximately ½ in. thick.

BORING THE BRASS

The practice at this shop is to bore the brass on a vertical boring mill as in Fig. 130 where the work is shown resting upon

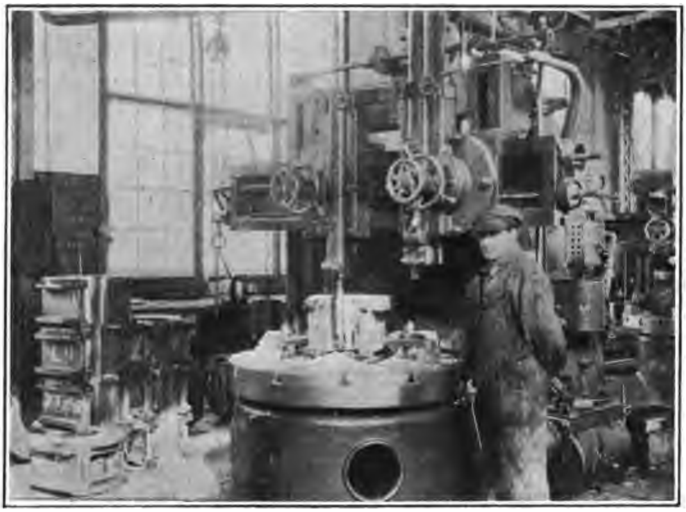


FIG. 130.—Boring the brasses.

two parallels on the table while two straps are used at each side to draw the work down snugly by means of its flanges. Ordinarily there is ⅛ in. of metal to be removed from each side in the boring operation, and this is done in one cut with a cutting speed of about 100 ft. per minute and a tool feed of 1/64 in. per revolution. The babbit thrust bearing is faced off at the same speed of the boring-mill table but with a side feed of the tool of ⅛ to ¼ in. per revolution of work. The amount of babbit to be removed in this facing operation ranges from say ⅜ to ½ in. in depth and at this depth of cut the surface is machined at one pass of the tool.

The planing of the boxes along the sides is done at this shop with several boxes in a string on the platen, but when few are put through in a lot they are not carried by a special fixture but held as represented in Fig. 131, with simple straps and table bolts. The boxes are here set with their open ends pointing in one direction and with the thrust of the cut taken by the end box which abuts against a platen stop.

The oil grooves are cut in the driver-box brasses by means of a pneumatic chisel. During this work the operator's eyes are well protected from flying chips by safety goggles.

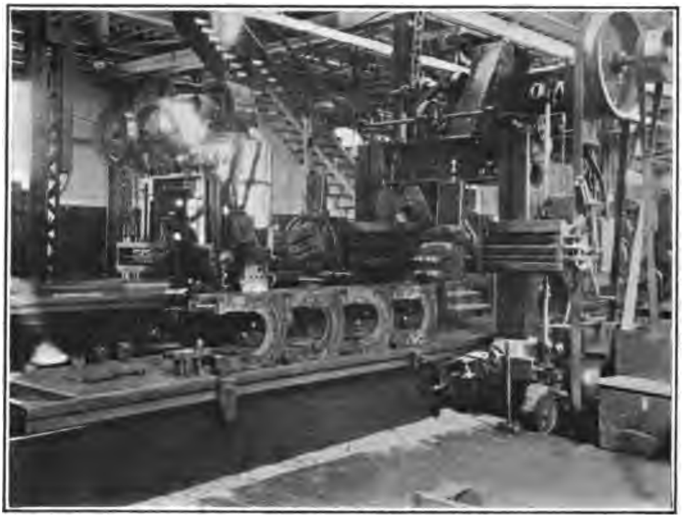


Fig. 131.—Planing boxes.

The various differences in points of practice in different railroad shops are well exemplified by the methods of handling driving boxes in various parts of the country. These methods in any shop are naturally determined in a great measure by the character of the machine-tool equipment available in the place for a given line of operations, the amount of work of the same kind machined at any one time, the general tendency of a given shop toward development of special fixtures and processes and so on. The interesting features of shop practice thus far described in this chapter are based upon methods and tools in Southern Pacific shops.

In the sketch, Fig. 132, is a templet from the Santa Fe shops,

as used in the lathe for driving-box brasses. This templet is provided with jaws resembling a steady rest and these jaws can be adjusted in every direction to suit different brasses. Details of this tool are shown in the engraving and it is apparent that any desired modification can be easily made.

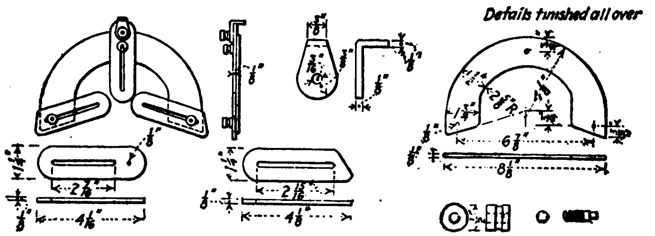


FIG. 132.—Template for laying off brasses.

A SLOTTER FIXTURE

The practice in some shops is to machine brasses in the vertical slotter. A fixture used for this is in the form of a disk which is set central with the slotter table and which carries three square head plugs upon which the brass is set. The fixture is rotated by hand in adjusting the work for the cut. The disk is then clamped to the table and the power rotary feed employed to revolve the brass past the slotting tool.

A setting templet is used in connection with this operation, which may be used in scribing the top end of the brass, and which facilitates the process of locating the work properly under the tool.

A DRIVING-BOX CHUCK

The line drawings, Figs. 133 and 134, illustrate a specially designed chuck for holding driving boxes upon a boring mill and for getting them in proper center very quickly. This chuck as described by J. K. Long has a base or bottom of solid cast iron finished to 3⅝ in. in thickness. In addition, it has a ring protruding ½ in. This is 1½ in. in width, and the outside diameter of the ring is 35 in.; inside diameter, 32 in. This ring fits in a corresponding ring cut in the table of the boring mill.

The diameter of the boring-mill table is 4 ft. 6 in., and the baseplate of the chuck is the same, thus presenting a neat and uniform appearance. Fifteen screws like *A* secure the chuck to

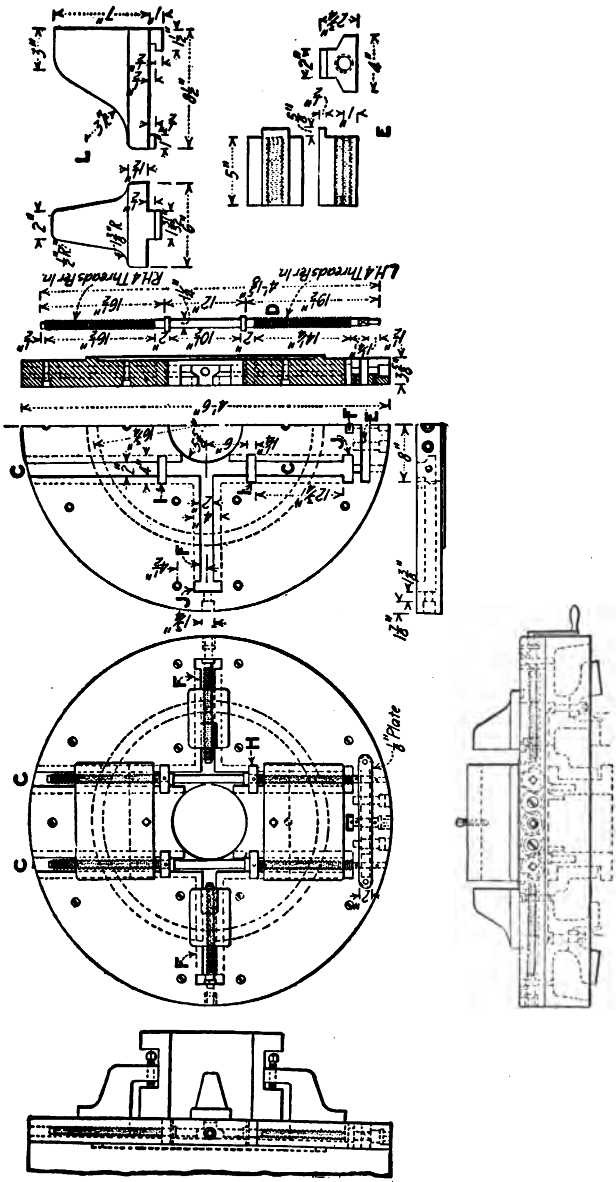


FIG. 133.—Driving box chuck and details.

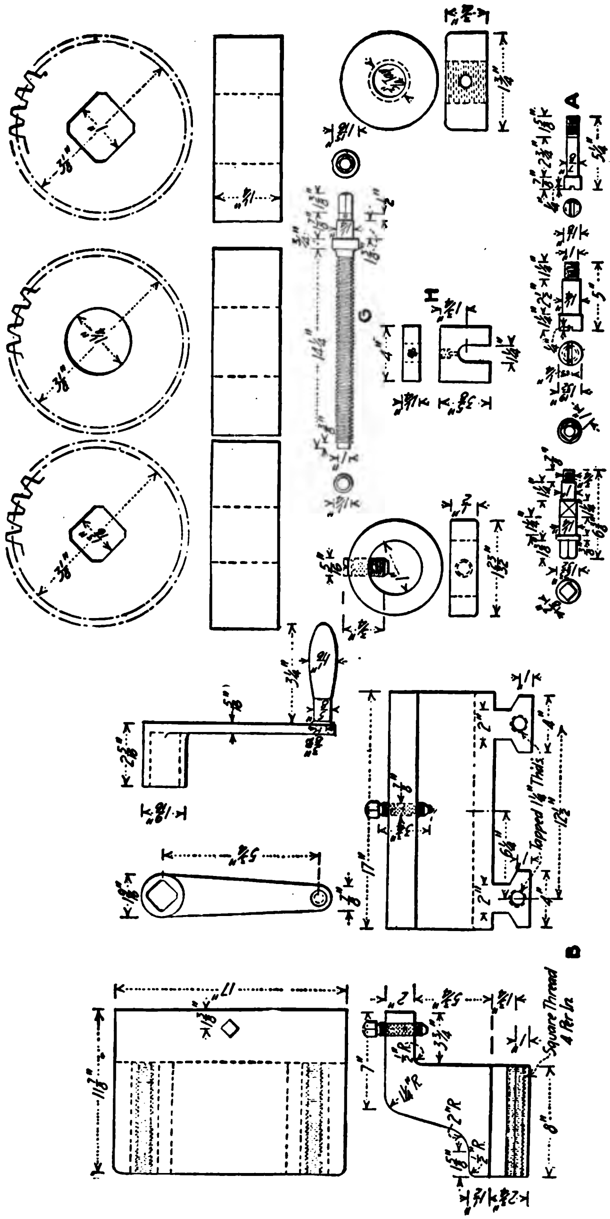


FIG. 134.—Details of driving box chuck.

the boring-mill table. The platen has in the center a hole $11\frac{1}{4}$ in. in diameter, for chips to drop into and also to clear the boring bar and tool. The detail *B* shows the main sliding jaws of the chuck; there are two such and they are moved apart or together up against the sides of the driving box, which are next to the driving-box shoes. These two jaws are planed on the bottom on two places 4 in. wide and 1 in. high. They are then beveled at a 30-degree angle to a width of 2 in., and these parts are neatly fitted to corresponding slots planed in the bedplate, as shown at *C*. One jaw is tapped right- and one left-hand, to suit the screw.

One end of the screw *D* has $2\frac{1}{4}$ in. more of thread than the other, and care must be taken to see that just this much of both screws is screwed into the block having the right-hand thread. Then the block having the left-hand thread is brought up against threads on the other end of the screws; both are turned, and the jaws move in toward the center. Before this much is put in place, two blocks, given as detail *E*, must be put in place, one each in the slots marked *F*, which are planed in the table at right angles to the jaw slots. One of these is tapped right- and one left-hand, and at *G* is shown the type of screw that moves them independently of each other.

The detail *H* represents a block that is dropped into place in the slots *I*. There are four of the blocks, but of course the two jaws that fit on two long screws must all be put in before these four blocks are put in place. Four slots, like *J*, are for clearance in planing out the slots; and where the short screws are concerned, the end forms a rest or backing for the shoulder near the end of the screws.

The two jaw screws are connected by gears, as illustrated, so that when the center gear is turned, both screws turn in unison in the same direction. When all the gears are in place, a $\frac{1}{8}$-in. wrought-iron plate with beveled edges is fastened over them as a gear guard to keep dirt out and also to keep a man's fingers out, a feature that is also important.

At *L* are shown details of one of the two blocks that are removable in order to put the driving box on or off. The base, or plate, is of cast iron; the jaws are steel castings, while the gears are of soft or axle steel, as are also the pins.

The two small blocks shown are for adjusting the box along the large jaw faces, in order to bore more or less out of the part that

rests on the axle. One of these blocks has to be taken out when the box is put on the machine or removed therefrom. That operation is easy, owing to the block being shorter than the part that moves it in against the box. When all jaws and set screws are tightened up, it would take about as much of a lift to loosen the box as would be necessary to pull the machine off its foundation.

CHAPTER VIII

MACHINING SHOES AND WEDGES

The handling of shoe and wedge work, like the methods on driving boxes and other locomotive parts, varies considerably in the different railroad shops and for this reason a number of illustrations are included in this chapter as reproduced from photographs taken in several different plants to show characteristic operations on shoes and wedges.

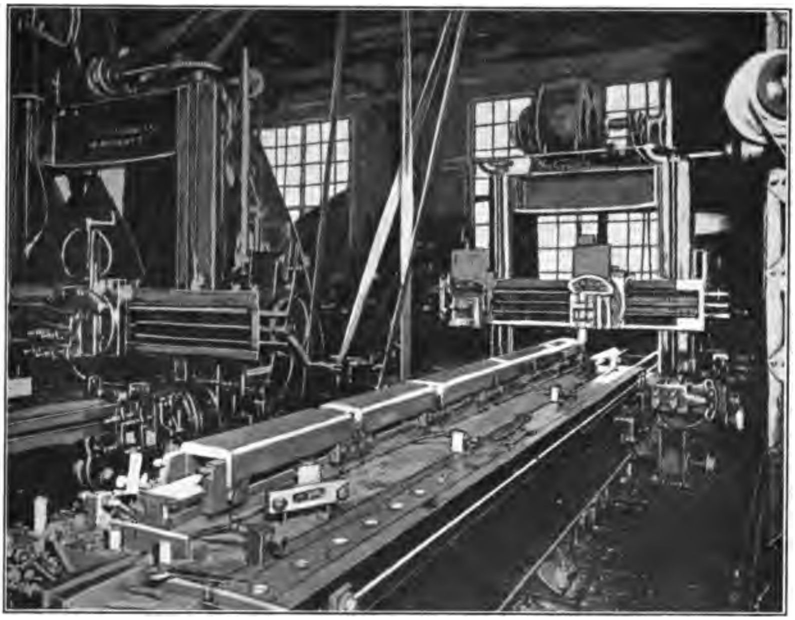


FIG. 135.—Planer fixture for shoes and wedges.

Thus, in Fig. 135 we present a view from the Oregon Short Line shops at Ogden, Utah, illustrating an interesting fixture for holding a half-dozen shoes or as many wedges, while the planing operation is performed.

The shoes and wedges as they come to the planer in the rough are first placed bottom side up on this fixture and secured by an end clamping device, which holds the work in such manner as to

leave all of the surfaces clear for the planer tool, with the exception of the face which rests upon the jack-screws set up from below.

The castings thus held open side up, are planed across the edges of the two side walls at *A*, Fig. 136. These walls are planed inside at *B* by duplex tools adapted for working on both surfaces, to finish the interior to suit the thickness of the jaws on the engine frame; and at the same setting the inside bottom *C* is also planed. Without any adjustment or reclamping, the two outer sides of the work, *D*, are planed down with two tools in the two planer heads.

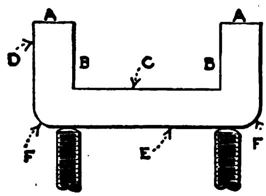


FIG. 136.—Setting work.

The shoes and wedges are placed in the jaws of the engine frame, and laid off to secure three working points, that is two on one side and one on the other. These points are center-punched and the work is then placed on the fixture in the position shown in Fig. 135 and adjusted by the set screws (of which there are four under each piece) until the entire series of center punch marks are exactly the same height above the planer platen when tested with a surface gage. Once positioned in this way, the clamping devices between each pair of shoes are tightened and the work is ready for the planing of the flat top face *E*, Fig. 136, and the rounding of the corners *F*.

The four jack-screws under each shoe enable the work to be adjusted very quickly, and in the case of the wedges, they allow the castings to be set to the necessary slope for the finishing of the taper surface.

Upon examining the planer fixture it will be seen that there is a thin plate on the top of the fixture which extends the full length and serves as a parallel for aligning the six castings for the planing operation. This plate has been found very useful in work of this character.

The clamping devices at the ends and between the shoes are adjustable along a T-slot in each side of the fixture to suit the lengths of the work. One of these clamps will be noticed on the platen, removed from the fixture. The construction will be clear upon inspection of the general view in Fig. 135 and the detail sketch in Fig. 137.

Referring to the latter engraving, the block forming the body of the device is shown at *A* with a projection at the center ex-

tending up well toward the top of the work. A wedge *B* with a flattened head fitting an elongated opening in *A* has a threaded shank passing down into the opening *C*, which is of sufficient length to allow a wrench to be used upon the nut by which the double wedge is operated.

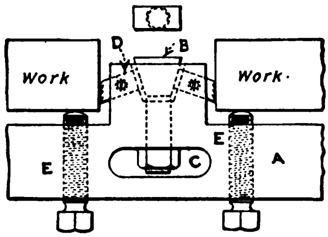


Fig. 137.—Clamping device.

When this wedge is drawn down, it forces the two obliquely located jaws or shoes *D* into the ends of the work, and as their outer ends are serrated, they force the work down fast upon the supporting screws *E*. Two small retaining screws through the side of the block *A* prevent the gripping members *D* from dropping out of their sockets, at the same time allowing them ample freedom to perform their work.

ANOTHER PLANER FIXTURE

A long fixture for planing shoes and wedges as used at the "Katy" line shops at Parsons, consists of a massive casting resting upon four parallel cross supports which provide for a clear space under the fixture body to give access to the screw heads below the base. The fixture body has a guide along the top surface for the work, and at each side or along the edge there is a slot running the full length to receive and control the series of adjustable blocks which carry the side clamping screws. The screw blocks are adjustable along the fixture slot to suit the length of the work which is to be planed.

The screws which are shown tapped up through the base from the underside are so spaced as to accommodate the different classes of wedges.

PLANING SMALL LOTS OF WORK

A common method of planing a fairly small lot of shoes and wedges at one time is shown by Fig. 138. Here a simple parallel fixture is secured to the platen of the planer and the work is clamped against the parallel ledge on the fixture by straps placed as represented.

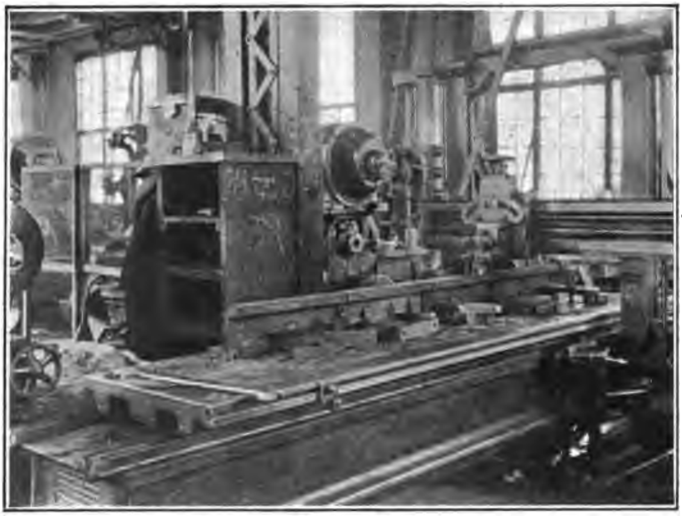


Fig. 138.—Method of planing edges of shoes and wedges without special fixtures.

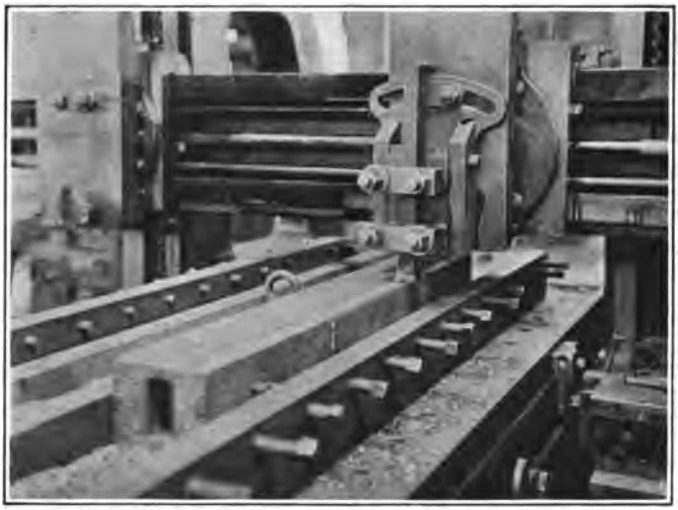


Fig. 139.—Large double fixture for planing shoes and wedges.

8

ANOTHER BIG DOUBLE FIXTURE

The two views, Figs. 139 and 140, are of fixtures used at the Sacramento shops of the Southern Pacific Company for planing shoes and wedges in quantities. It should be stated that at the time the fixture in Fig. 139 was photographed, the last end of a run of shoes was going through the planing process, hence, only a few castings are shown in place in this view.

The general features of this fixture are well brought out by the engraving. The fixture casting is in the form of a double channel of very heavy section, with a row of 7/8-in. set screws tapped

FIG. 140.—Double planing fixture on wedge operation.

through each of the outer walls. The channel portions are each wide enough to admit two rows of shoes as indicated for the planing of the edges, the work being secured tightly in place by the clamp screws in the side of the fixture. Two heavy eye bolts are tapped into the fixture body to allow the casting to be picked up readily by the big crane when putting it in place or when removing it from the planer.

In Fig. 140 two rows of wedges are shown set up on their fixture for the planing of the taper surfaces. The wedges are placed in pockets where they are given the proper angular setting for the sloping surface and here again the work is clamped fast by the set screws tapped through the side walls of the fixture.

USING THE SHAPER ON SHOES AND WEDGES

The photograph Fig. 141, represents the use of the draw-cut shaper for machining the outer faces of shoes and wedges. A wedge is shown in place in the vise in this view. The work is stiffened inside at the deep end to prevent springing under the closing action of the vise jaws by means of a strut or jack-screw.

FIG. 141.—Finishing shoes and wedges in the draw-cut shaper.

FIXTURE FOR LARGE WORK

The line drawing, Fig. 142, illustrates a special form of fixture described by H. Brooks, this fixture being used for holding shoes and wedges of large locomotives of the Mikado class. These wedges are so much wider than those on the average locomotive that they can hardly be handled to advantage in the usual way, and the device should be of interest to those having to do with the upkeep of large locomotives. It is pointed out that the fixture has proved so satisfactory that the design is also now used for smaller wedges as well.

As will be seen in the view at the right, the shoe *A*, is held by one edge which does away with the necessity of using jacks between the flanges, for although it is held by only one flange, the grip is so firm that the work does not move under the heaviest cut.

The lower side of the fixture has a tongue to suit the slot in the planer and there are four ¾-in. jack-screws, one at each corner, for tilting the fixture so as to plane at the desired angle to suit the marks which are laid out. The rest of the details are clearly shown and require no explanation.

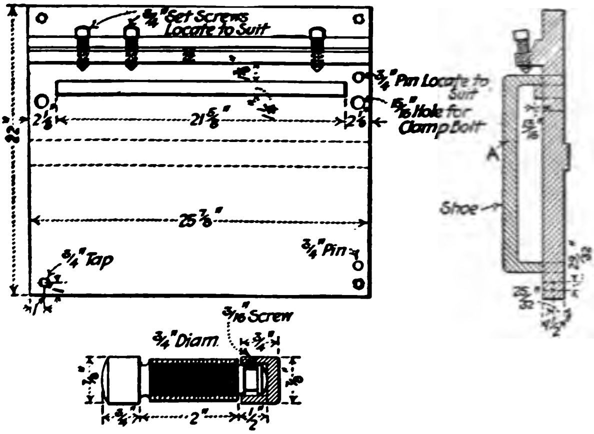


Fig. 142.—Vise for planing large shoes and wedges.

TOOLS FOR FINISHING BOTH SIDES OF SHOES IN ONE OPERATION

The planer tools in Figs. 143 and 144 are for finishing both sides of shoes and wedges in one operation. Several sizes of these tools have been made in the toolroom at the Sacramento shops. The photograph, Fig. 143, shows two sizes only, namely 4 in. and 4½ in. The drawing, Fig. 144, covers details of three sizes from 3½ to 4½ in. The shanks are all of 2¾ by 2-in. section with heads to suit the working width of the tools.

The tool points or cutters are ¾ in. square and are fitted into square holes cut through the heads at an angle of 45 degrees to the centerline. Adjustment of the tools is by means of two hollow-head set screws at the rear, one of which acts upon the forked shoe *A* while the other bears against the pin *B* which passes through the opening in *A* and so comes into contact with the rear end of the tool point. When the tools are set they are secured in their holder by the set screws tapped in through the top.

Details of these parts and of the setting gages *C* are all included in the drawing.

FIG. 143.—Planer tools for shoes and wedges—(both sides at one operation).

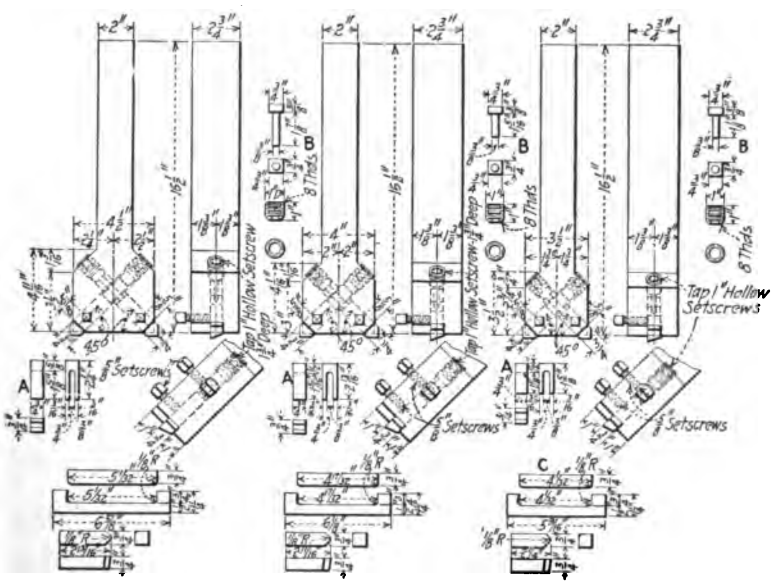


FIG. 144.—Planer tool details.

SHAPER TOOLS WITH BACK-STROKE RELEASE

The tools in Figs. 145 and 146, turned out in the same shop, are made with back-stroke release. One size only is shown in the views but there are several sizes in use in the shop. The size illustrated is for work from $3^{13}/_{16}$ to $4\frac{1}{2}$ in. across the width to be planed out.

The drawing, Fig. 146, shows the tool in all its separate parts and also assembled. The body A is of machine steel with a head like that on a box tool for the turret lathe. This head is adapted to carry two tool blocks B which serve as holders for the tools proper. The two blocks or holders B are bored through near their lower inner corners with $\frac{1}{2}$-in. holes which receive the hardened steel pin C. This pin is seated in holes bored in the body of the device and is secured at its inner end by a headless screw which bears upon the end of the pin. The two holders are adapted to rock about the bearing pins and thus relieve the cutting tools upon the back stroke.

FIG. 145.—Adjustable shaper tool with back stroke release ($3^{13}/_{4}$ to $4\frac{1}{2}$ in.).

In the view at the left in the drawing, the tools are shown assembled and it will be seen that between the two holders B there is a recoil or pressure spring D which acts against the inner sides of both holders to force them solidly down to their seats on the body of the device. On the back stroke of the machine, this spring allows the tool holders to swing forward about their pivot pins C, thus giving the back-stroke release action.

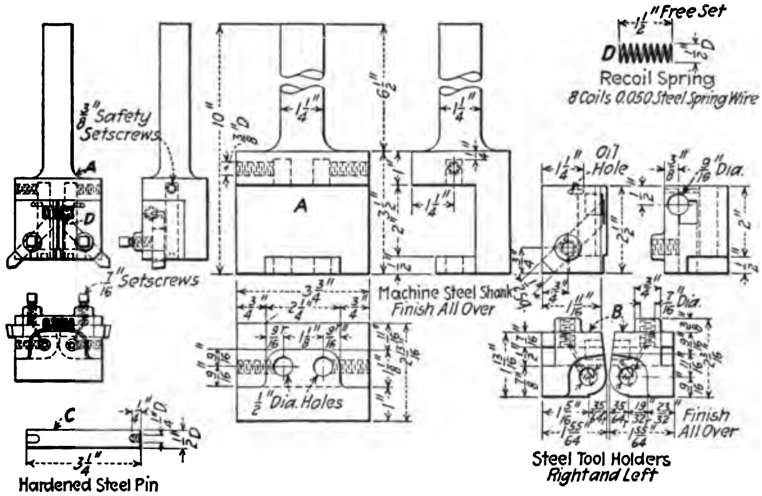


FIG. 146.—Shaper tool details.

A MILLING FIXTURE

The milling machine is used to a considerable extent on shoe and wedge operations and Fig. 147 illustrates a fixture employed

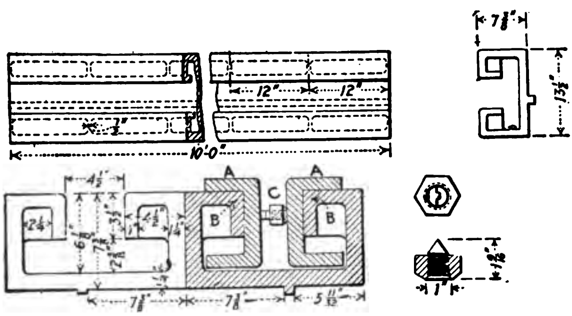


FIG. 147.—Fixture for milling shoes and wedges.

at the Santa Fe shops for milling these parts in long rows or strings.

The fixture is 10 ft. long and holds 20 shoes. As can be seen in the cross section, the shoes *A* are supported by their inner surfaces on the corners of the fixture at *B* and they are held in place by the small jack-screw *C*. The principle dimensions of this fixture are clearly shown on the drawing.

CHAPTER IX

ECCENTRICS, LINKS AND TUMBLING SHAFTS

The engravings in this chapter illustrate some of the methods and tools used in different railroad shops for machining such parts as tumbling shafts, eccentrics, links, rocker arms, etc.

Thus Fig. 148 shows a method of turning the journals on tumbling shafts, always an awkward piece of work to handle to advantage owing to the swing of the arms.

In this case the work is fixed between centers on the lathe but the turning operation instead of being done with a regular lathe-tool is accomplished by means of a hollow mill which is rotated by a sleeve connection on the nose of the spindle. The hollow mill is fed along the work by means of a forked bar which fits at the rear end in the tool post of the lathe while the other end engages in a circumferential groove with which the hollow mill is provided.

The method of holding the hollow-mill cutter in a slot in the body of the tool and the means of adjusting by screw to enable it to cut to the desired size will be seen in the engraving.

This lathe like many others in railroad shops is provided with a light crane which enables the operator to swing a heavy chuck onto the spindle or to remove it with little effort. When the chuck is out of use it hangs suspended on the crane until again required.

Another method of handling this awkward tumbling shaft work is to make use of a horizontal boring machine. The table is dropped sufficiently to clear the work and the turning tool is carried at the top of an upright post made with a flanged base which is secured to the table by means of a pair of stiff straps.

The tumbling shaft is placed between centers and revolved by a long driver of special form. This driver is screwed directly onto the spindle nose and its long arm is slotted at the outer end to receive a block by which the end of the arm on the tumbling shaft is secured for operation. This gives a rigid drive on a long radius.

Another difficult piece to machine is a rocker arm. This is sometimes held on the drill-press table while the hub is turned

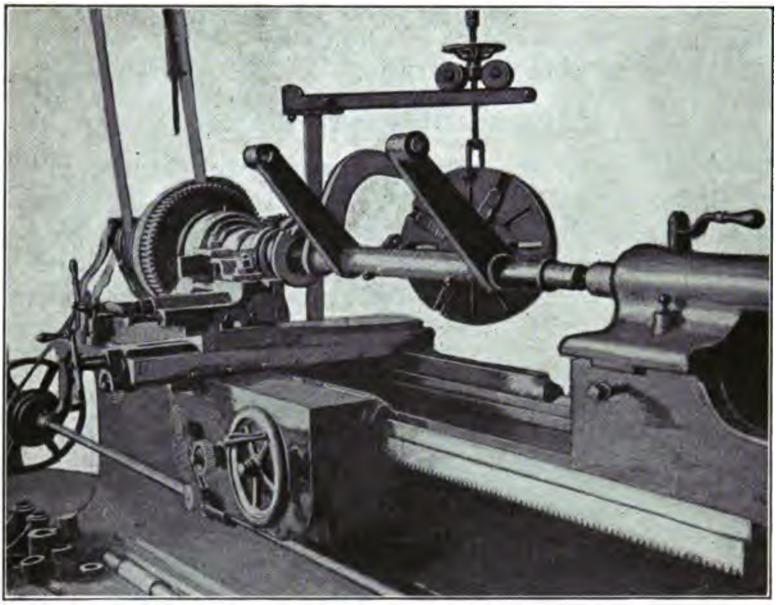


FIG. 148.—Turning journals on tumbling shafts.

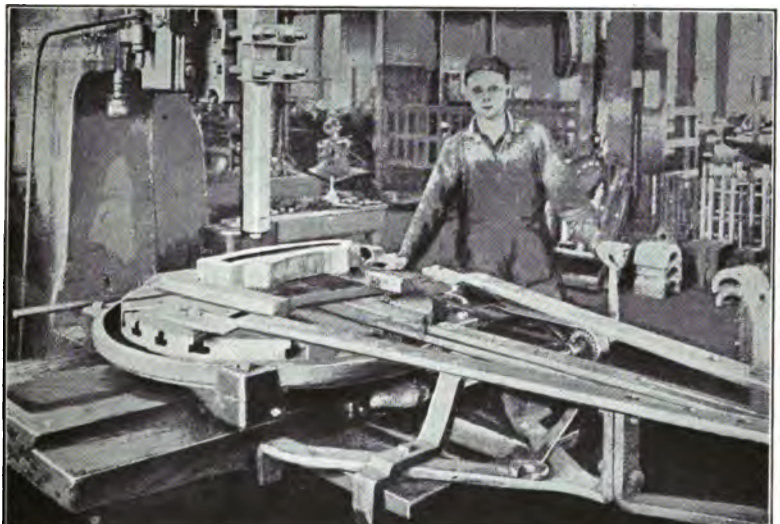


FIG. 149.—Fixture for machining links.

to diameter by a hollow mill. This mill is formed with two stiff wings, which receive inserted blades and these cutters as well as the pilots, are readily changed to suit the work in hand.

FIXTURES FOR MACHINING LINKS

The fixture in Fig. 149 is for machining links in the slotter. The plate upon which the link is secured when undergoing machining operations, is placed upon the table of the slotter and connected to the table merely by a pin which is free to slide in a cross-wise slot in the bottom of the plate. This plate is pivoted at the proper radius by two projecting arms which pass over a

Fig. 150.—Finishing slot in link with hand grinder.

stud secured in the adjustable central member of the supporting frame work. The work is fed past the tool by the regular cross-feed of the slotter and the pivoted arms cause it to move in a circular path of the desired radius. By changing the slotter tool both the outer and inner surfaces of the link are finished to the required curve with facility.

HAND GRINDER FOR LINKS

The illustration, Fig. 150, shows a convenient hand appliance for touching up and finishing the inner bearing surfaces of links while the work is held in the bench vise in any position to suit the operator. The appliance is a small air-driven grinder with spindle of sufficient length and wheel small enough to permit the workman to cover any point on the bearing surfaces of either

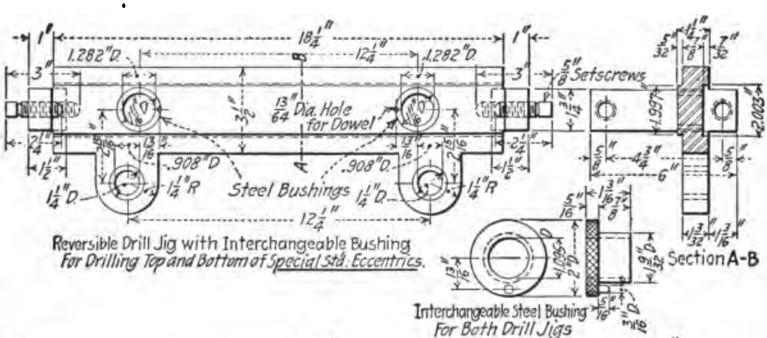
the concave or convex member of the link. The driving member of the machine is a fan-shaped wheel with blades that are 2½ in. across the diameter by 2 in. wide. The vanes have a curved form to catch the air jet and they have an angular position of about 45 degrees relative to the axis of the spindle, so that as the air at say 80 lb. pressure is admitted at the side of the casing and against the radial edges of the vanes they rotate the spindle and grinding wheel at high velocity.

The outfit weighs but a few pounds and is readily manipulated by means of a knurled handle attached to the rear head of the casing.

OPERATIONS ON ECCENTRICS

The joints of eccentrics are finished by planing, milling, slotting or in the shaper. String fixtures are as useful for such

FIG. 151.



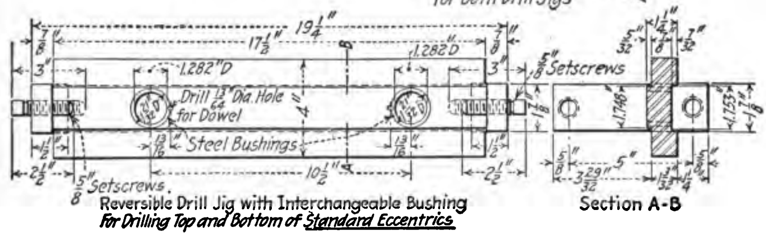


FIG. 152.—Eccentric jigs.

parts where made in sufficient quantities as for other engine parts. A fixture of this kind for milling the joints of several eccentrics at one setting consists simply of a central plate having a ledge on each side on which the eccentrics rest, and a strap which holds them in place against the center plate or web. Five eccentrics are held on each side and are easily levelled up so that

two milling cutters on the horizontal machine mandrel face the surfaces quickly.

The line drawings, Figs. 151 and 152, represent types of reversible drill jigs with interchangeable bushings. These are for drilling top and bottom of eccentrics. The jig is provided with tongue and groove-locating section, and with set screws at each end. The slip bushing fits the permanent bushings in the jig.

BORING AND TURNING

With the two parts put together there are various ways of carrying on the boring and turning of the eccentrics. Thus,

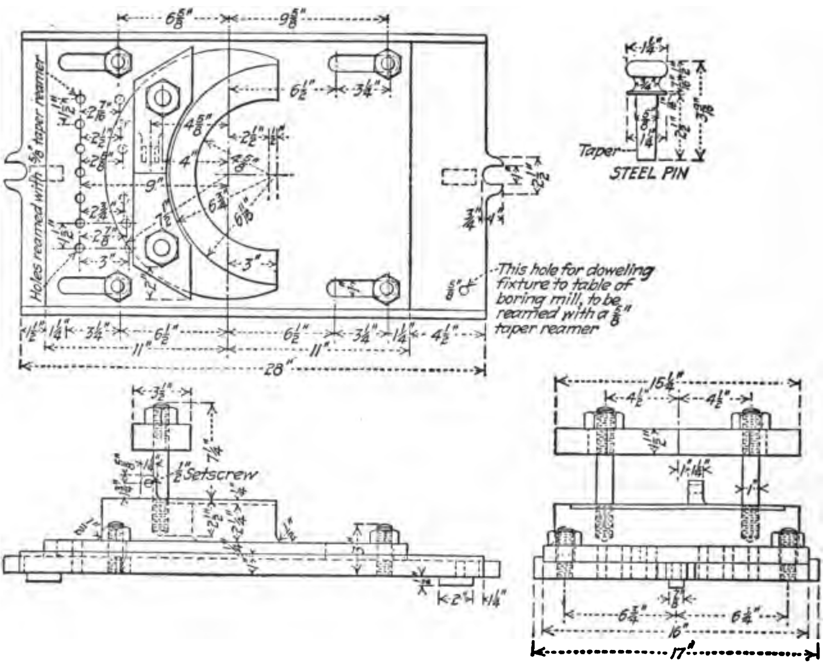


Fig. 153.—Fixture for turning and boring eccentrics.

Fig. 153, shows a chuck for holding the work for both turning and boring on the vertical-boring mill. As seen in the drawing, the fixture is made for use with several sizes of eccentrics, as there are a series of locating holes and a plug by which the device may be set to suit the required offset of the eccentric without using measurements. Each of these locating or stop holes,

locates the fixture in the center while in this position for the turning of the outside surface. But the corresponding hole of the set gives a different throw for the hole to be bored in the eccentric. The method of placing the locating holes allows small differences of eccentricity to be secured without interference of the locating holes. These holes are all marked so that the operator knows just what throw each hole gives.

A gang arbor is useful for turning eccentrics in the lathe. The two parts of the eccentric are bolted together on such a mandrel for the turning of the outside diameter. The mandrel has a flange on one end which is bolted to the faceplate at the correct amount of eccentricity so as to bring the center at the other end in the correct position to be supported by the center

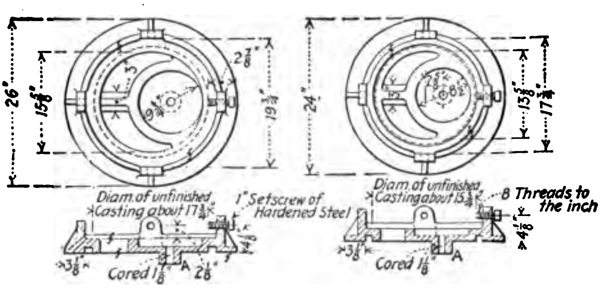


FIG. 154.—Fixtures for boring eccentrics to fit axle.

in the tailstock. After this it is a straight job of turning except for the tongue at the center which fits the groove in the eccentric strap.

Another design of boring fixture is shown in Fig. 154. This illustration shows how the eccentrics are held by four set screws and how they are located for boring by the projections *A* which indicate the center of the driving axle. The drawing covers important dimensions for two sizes of fixtures. These fixtures can be used in either the lathe or the vertical-boring mill.

MAKING RINGS

Brass rings for eccentrics are machined in the manner indicated in Fig. 155, where a casting long enough for several slip rings is shown held in the four-jawed chuck of a 30-in. lathe, while one ring after another is machined and cut off to the proper width. In this process the outside of the casting is first

rough-turned for a distance sufficient for the machining of one ring. The inside is then bored, the outer end faced as required, the outside turned to size, and the ring cut off. The boring tool is carried in a long stiff bar shown in the toolholder on the lathe and the same bar is used for the turning tool, both outside and

FIG. 155.—Boring brass ring for eccentrics.

inside tools being inserted, cutters readily placed in the bar and adjusted as required.

Another type of boring and turning tool for the lathe on work of this kind, is made up to carry two bars. These are placed parallel with their axes over 4 in. apart and one bar carries the turning tool while the other carries the tool for boring.

CHAPTER X

LOCOMOTIVE FRAME WORK

The repair of locomotive frames is always a more or less difficult undertaking owing to the peculiar form of the work, the weight of the parts to be handled and the general character of the operations required to put the member into proper condition. Much of the work of this nature is of a kind coming within the province of the blacksmith shop, and oftentimes the facilities of this department of a railroad repair shop are none too complete for the satisfactory overhauling of frames from a big engine. There are, however, many shops where frame repairs, no matter how heavy the work may be, are taken care of with facility.

A typical frame construction is shown in Fig. 156, the general dimensions being of interest as showing the overall length, the center distance between boxes, etc. The frame illustrated is one of a pair, right and left, made to uniform dimensions, and it has a total length of 42 ft. 8½ in. The weight of each side member of the pair runs say to 3½ or 4 tons, and this fact coupled with the liberal overall dimensions of the member makes it necessary to use considerable skill and judgment when a new section is to be welded on, or when certain portions are to be machined in the shops either before or after welding up the complete frame.

Owing to the great length referred to, and to the peculiar form of the member, it is customary in some shops whenever a new section is to be welded into the old frame, to do all the machine work possible on the new portion before it is welded into place. This means that additional care must be exercised in the blacksmith shop to preserve alignment so far as possible and to maintain original overall lengths and other dimensions.

The half tone, Fig. 157, illustrates the method of planing the forward lower portion of such a frame preparatory to sending it to the blacksmith shop for welding to the frame proper. In

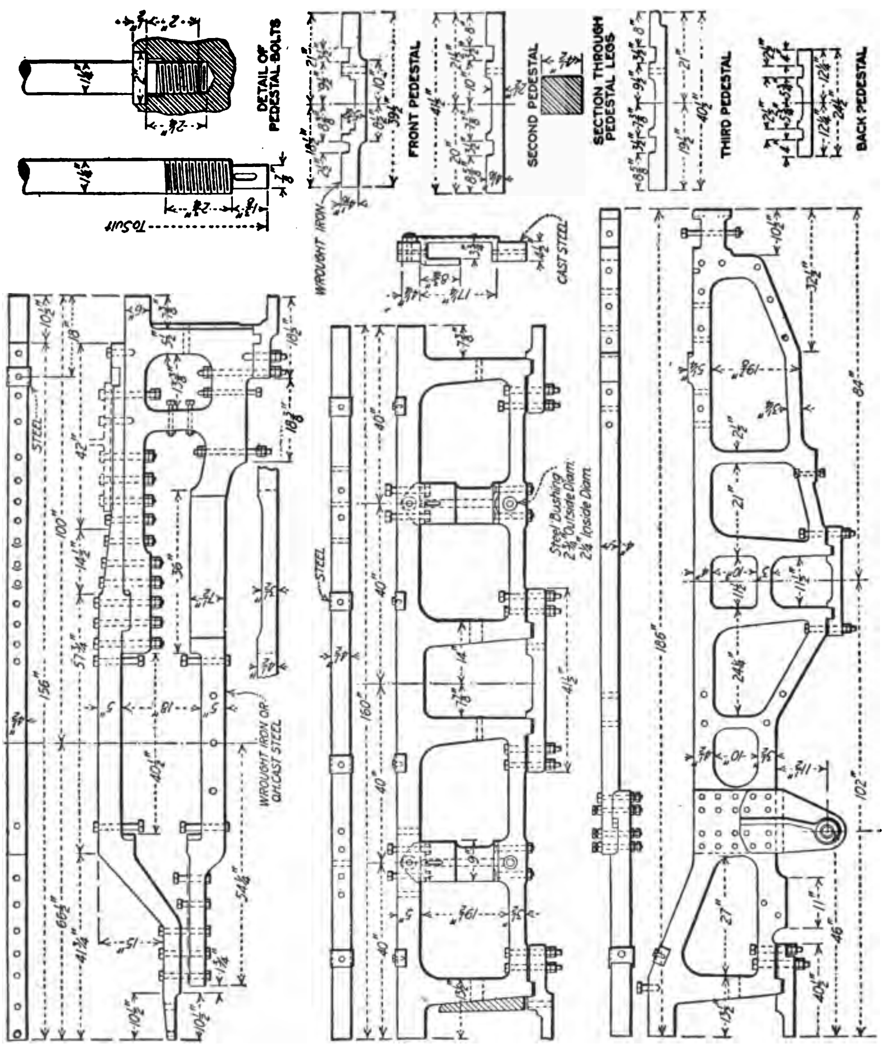


FIG. 156.—Details of locomotive side frame.

Fig. 158 another section of a frame is shown with a cold saw cutting off the end, and in Fig. 159 this section is represented under the radial drill where the stud and bolt holes are drilled before this new portion is welded into the body of the frame.

Fig. 157.—Planing a frame section.

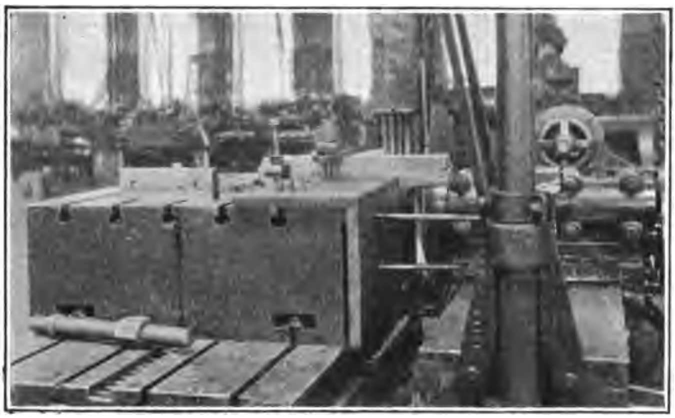


Fig. 158.—Cutting off end of a frame section.

A SMITH SHOP FIXTURE

Referring now to operations in the smith shop, Fig. 160, illustrates an arrangement devised especially for frame work, which enables such parts to be handled with convenience either on the

floor, on the crane hook, on the anvil or under the power hammer. It consists of a pair of steel sheave wheels which are divided or

FIG. 159.—Drilling section of frame.

split across the center so as to form a pair of semi-circular clamps. These, when bolted to the frame as shown, are adapted to receive

FIG. 160.—Handling a frame in the forge shop.

the endless chains from a pair of small pulleys hung in blocks which are themselves hooked into holes in the equalizing bar

suspended from the main crane hook. With the apparatus resting on the floor and the chains off, the entire outfit, frame and all, may be rolled over to any desired angle for laying out, inspection or other purpose, and when picked up by the crane the frame can be revolved in the sheave chains to whatever position may be desired.

In the view, Fig. 160, the work is shown with the frame suspended and turned flat with one end resting upon a supporting anvil. In this position a new section to be welded in has been secured in proper place relative to the main frame and clamped for the welding operation by a pair of side plates which hold the two members flush with each other and in correct alinement for

Fig. 161.—Laying out frames.

the operation. These clamping plates are arranged so as to be applied quickly and after the heated work has been swung out of the furnace they aid very materially in maintaining the desired conditions of alignment while the work is under the hammer.

It will be noticed upon careful inspection of the engraving that two sheet metal plates are attached to the side of the supporting blocks for the sheave chains, and these plates completely fill the triangular openings directly over the sheave wheels clamped to the engine frame. The purpose of these plates is to prevent the workmen from thoughtlessly grasping a chain or the edge of the wheel with their hands with the attendant possibility of having one or more fingers crushed between chain

Fig. 162.—A frame job on the slotter.

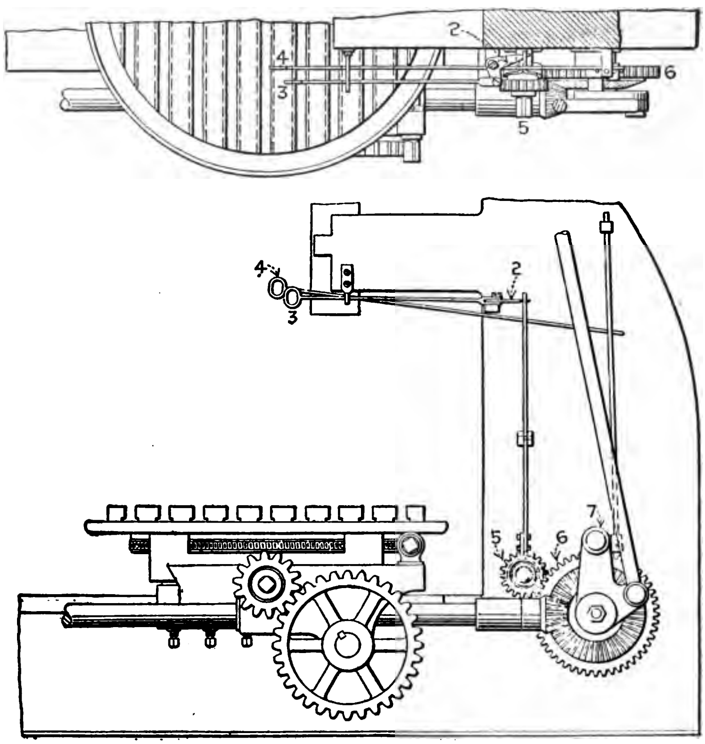


Fig. 163.—Two shift levers for a slotter.

and wheel. Both shields referred to have the inscription "SAFETY FIRST" painted upon their faces in conspicuous characters and there is little excuse for anyone trying to wedge his hand into the danger zone.

OTHER SHOP OPERATIONS

The views which follow show a number of interesting operations in the machine shop. In Fig. 161 two frame sections are seen resting on heavy trestles for the laying out of the work.

FIG. 164.—Setting the frames over the pit. The beginning of the erecting of a locomotive.

Figure 162 shows a frame on the slotting machine where a large proportion of the machine work on such parts is attended to.

In connection with slotter operations, the device shown by the line drawing, Fig. 163, should be of interest. This represents a method of putting two controlling levers on a slotter to save a lot of time as with these the operator does not have to climb over his work or go around it to shift his cross feed.

The illustration is very plain and shows that lever 3 throws gear 5 in or out of mesh with gear 6, and lever 4 raises and lowers dog 7 which throws the feed in or out as desired.

Before these levers were put on the operator had to go over and shut off the power feed some time before the job was finished and then go back and feed by hand, which, of course, was lost time. With the arrangement shown the power feed is left on until the work is very close to the line for size then the feed is easily disconnected by the levers.

Figure 164 should interest the reader as showing the setting up of the locomotive frames over the shop pit, the beginning of the process of erecting the engine.

CHAPTER XI

DRIVING WHEELS AND AXLES

The illustrations in this chapter show methods and tools in various railroad shops about the country for taking care of work on driving wheels, tires, crank pins and driving axles.

The first of these views, Fig. 165, illustrates the machining of a driving-wheel center on the vertical-boring and turning mill. The method of holding the work and applying the two tools is shown too clearly to require explanation. For boring a driving-

FIG. 165.—Machining a driving wheel center on the vertical boring mill.

wheel tire on the vertical mill three shoes are placed on the table of the mill and these are provided with set screws for engaging the outside of the tire. They are also provided with swinging straps which pass up over the outer face of the work and bring three set screws into position for holding the tire down in place. At the same time the interior of the work is left entirely clear for the operation of the boring tool.

ALLOWANCES FOR PUTTING ON TIRES

The accompanying table gives the practice of the Southern Pacific Company in respect to the allowances for borng tires for various sizes of wheels. This table covers tires for wheels from 45 to 84 in. inclusive.

Nominal outside diameter, inches	Diameter of wheel, center	Diameter to bore tire	Nearest 64th
45	38	37.9603	$37\frac{31}{32}$
51	44	43.9505	$43\frac{61}{64}$
55	48	47.9500	$47\frac{61}{64}$
57	50	49.9406	$49\frac{15}{16}$
63	56	55.9308	$55\frac{59}{64}$
69	62	61.9209	$61\frac{59}{64}$
73	66	65.9144	$65\frac{29}{32}$
77	70	69.9078	$69\frac{29}{32}$
79	72	71.9045	$71\frac{29}{32}$
81	74	73.9012	$73\frac{29}{32}$
84	78	77.8947	$77\frac{57}{64}$

Analysis of this table will show that the different allowances for shrinking on the tires of different sizes, starting with 0.039 in. for the smallest or 45-in. size, increases by practically 0.010 in. for each succeeding size up to 78-in. wheels where the shrinkage allowance becomes 0.085 in., the increment of advance then becoming about half that between the smaller sizes and reaching in the case of the 84-in. drivers an amount equal to 0.105 in. or virtually $\frac{1}{10}$ in.

Reference to different methods of heating tires or removing and shrinking on will be found at another point in this chapter.

TURNING TIRES IN THE LATHE

In Fig. 166 a big pair of driving wheels will be seen in the lathe for the turning of tire treads and flanges and the finishing of the axle journals.

The tools used for turning treads and flanges are made up in various ways in the different shops, particularly in reference to the broad faced finishing tools and forming tools for giving the proper shape to the flange and tread of the tire.

The character of the tools used in one well known shop is best shown by Fig. 167, which represents a pair of truck wheels in

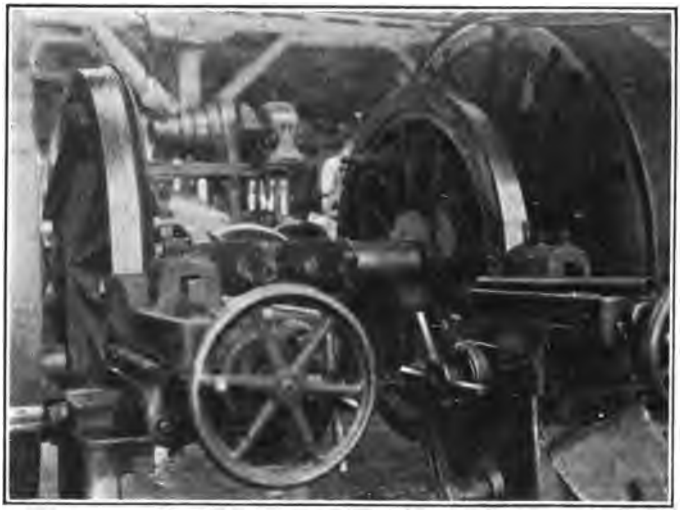


FIG. 166.—A pair of big drivers in the wheel lathe.

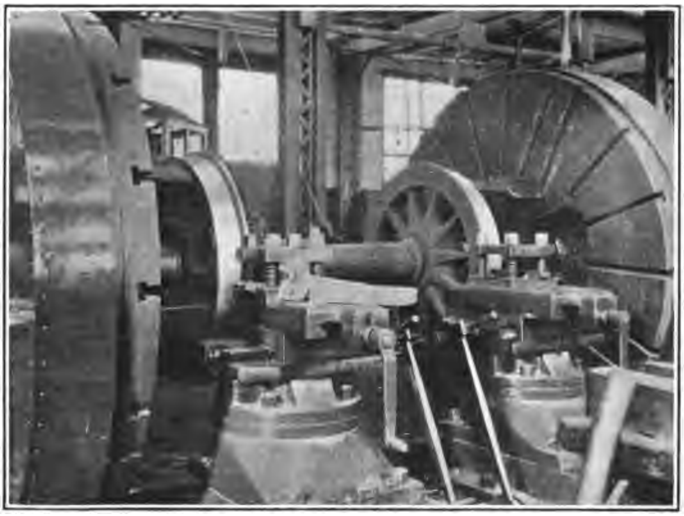


FIG. 167.—Turning treads and flanges of truck wheels.

another big wheel lathe. The work is roughed out with hog-nose turning tools; then the treads and flanges are finished with the broad-face tools and formed tools shown on the cross slide

of the lathe. A detail of one of the pair of forming tools is shown in Fig. 168, and as there represented, the cutting tool proper is a heavy block of steel bolted to a seat on the 2 by 3 in. holder. The tools themselves are of Mushet steel 1½ in. thick, with the body of the tool formed ⅛ in. lower than the actual cutting edge so that the narrow edge around the formed section of the tool is readily ground off when sharpening, without having the entire upper face of the block dressed off. The form tools are secured to their heavy holders by two bolts. The back and side thrust on the tools is taken by shoulders on the tool holder against which the edges of the tool abut when clamped in place by their bolts.

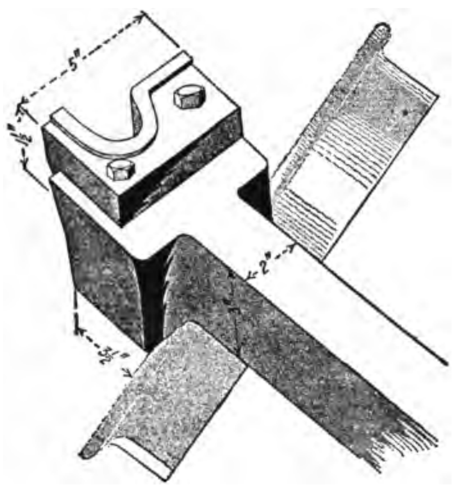


Fig. 168.—Details of tread forming tools.

In turning steel tires here the rough turning is accomplished usually with the work running at about 15 ft. per minute, the turning tool having a feed of ⅜ in. per revolution of work and a depth of cut of ¼ in. With the finishing cut under the flat-form tool the wheel is revolved at a circumferential speed of 9 to 10 ft. per minute and the same rate of speed is maintained when forming the flange. In fact, the final finishing of the beveled tread and the flange is accomplished with one and the same tool, about 1/16 in. of metal being left in the roughing process for removing with the form tool.

Another built up tire-finishing tool is illustrated by Fig. 169. The cutting edge of this tool will be seen in the foreground of the group photograph, Fig. 169. It is a piece of high-speed steel made a little over ¾ in. thick in the rough so that it will face down to ¾ in. in grinding. It is afterward used in service until ground down to a thickness of ⅜ in., so that the life of the tool is over an extended period. The holder or base block seen near the lower left-hand corner, is cut out to the form of the high-speed

section and milled away at the front to give ample clearance behind the cutting edge. Below the portion cut out for a seat for the tool there is another step milled away to form liberal space for the flowing in of the welding steel under the action of the acetylene torch or the electric arc. A pair of completed

FIG. 169.—A built up tire forming tool.

tools, right- and left-hand, are included in the background of the group of parts, Fig. 169.

A GAGE FOR MEASURING WEAR OF FLANGE AND TREAD

An interesting form of gage used for testing driver and trailer wheel treads is illustrated by the line drawing, Fig. 170. This

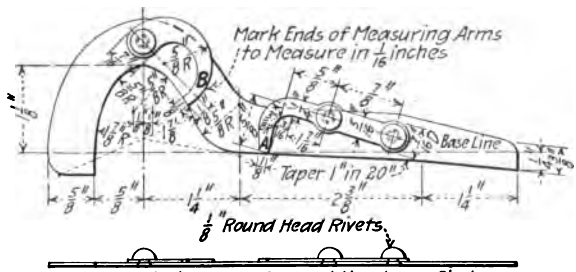


FIG. 170.

gage is adapted to measure the wear on the tread and on the inside of the flange by means of two swinging points *A* and *B* which come in contact with the surfaces noted. The ends of the hooked-shaped gage points are graduated to read directly in

sixteenths, but very much smaller amounts may be read by inspection.

LIFTING DEVICES FOR WHEEL WORK

Two handy appliances for lifting wheels and tires are illustrated by Figs. 171 and 172. The first of these is a bar with loop and eye-bolt for the crane hook and is represented in the engraving as used in lifting driving wheels in and out of the large wheel lathe.

Fig. 171.—Lifting rig for wheel lathe.

The device in Fig. 172 is used in lifting tires on and off of the boring-mill table without danger of striking the machine heads as often occurs when lifting directly by the chain method. The supporting bar is shown secured to the edge of the tire by a taper wedge driven in between the outer surface of the tire and the bent end of the bar. By driving this key out the tire is released at once.

Two other tire-lifting outfits are shown by Figs. 173 and 174. These are described by J. K. Long as follows: With the tongs shown in Fig. 173 the tires are lifted by the flange, which is

always placed uppermost to avoid difficulty in getting the hooks under the edge of the tire. The lifting hook *A* fits into the plate

FIG. 172.—Lifting device for tires.

B, which is $1\frac{1}{4}$ in. in thickness and 12 in. in diameter, with three $1\frac{1}{8}$-in. holes equally spaced on an 8 in. circle. The center hole

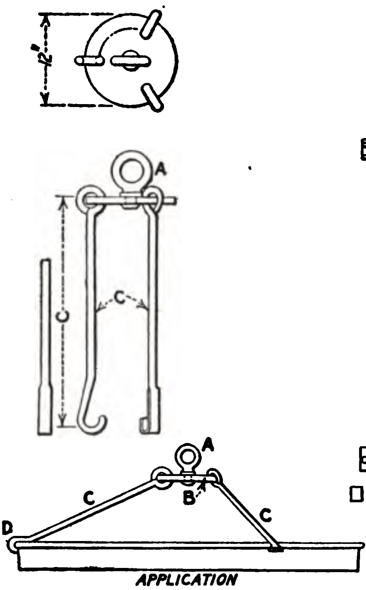


FIG. 173.

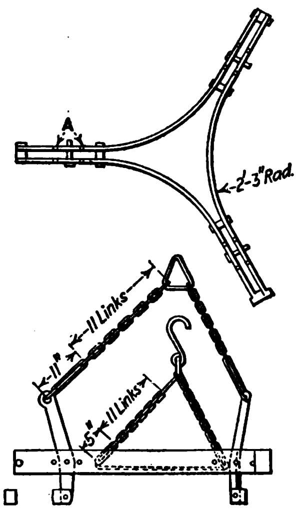


FIG. 174.

Two types of tire lifting tongs.

is $1\frac{1}{4}$ in. The three hooks are made of 1 in. round iron with eyes which fit into the holes in the circular plate, and the lower

end is bored flat to fit the tire flange as shown at D. All necessary dimensions, including the proper length of the hooks C, are given in the illustration.

When lifting blind tires, or tires without flanges, the device shown in Fig. 177 is used. The frame of this is made up of three pieces of 1 by 4½ in. iron bent to the radius shown and bolted together in the manner indicated. Three 1¼-in. holes are drilled in each piece as shown at A. These allow the gripping levers to be transferred to different points for different sizes of tires. Those shown are designed for sizes from 46 to 54 in. The arrangement and dimensions of the gripping levers are indicated.

FIG. 175.—Rail rack for wheels, and method of heating tires.

The necessary pull for lifting holds the ends in firm contact with the inside of the tire. The levers are arranged to have greater leverage or gripping power as the size, and consequently the weight, of the tires increases.

The short chain shown below is for carrying the lifter by crane wherever it may be needed. There is a ¼-in. plate under this chain which carries it when it is not in use.

HEATING AND REMOVING TIRES

A few illustrations are here presented to show various methods in use at different shops for heating and removing tires from the driving-wheel centers. Just outside the shop building, Fig. 175, there are a pair of rails supported upon piers of such height that the largest sizes of drivers will swing clear of the ground when

their axles are resting upon the rails, and here all driving wheels coming to this shop are placed when their tires are to be removed or replaced. A special long-arm crane is installed at the end of the rails for handling drivers on and off the supporting structure.

Referring again to Fig. 175, this view illustrates a Mahr oil heater for tires and shows the method of confining the heat to the circumference of the work by means of a sheet metal hood which is placed completely around the wheel, leaving merely a narrow opening at the bottom in front of the hood to admit the torch, or head, of the apparatus by which the heat is transmitted

Fig. 176.—Heating a large tire.

to the work. The nature of the heater proper is well shown, and the arrangement of oil tank and oil and air pipes will be understood from the illustration.

With this method of heating only a few moments are required to expand the tire sufficiently to permit it to be taken off of the wheel center.

FURTHER ILLUSTRATIONS OF TIRE HEATERS

The general view, Fig. 176, illustrates in the back ground the yard storage for driving-wheel tires in a big Western plant where each size of tire is placed in a separate section of the storage space. There are a number of fuel oil heating rings for the dif-

ferent sizes of tires, these being hung up on racks when not in service. In the foreground one of the oil heaters is shown in use on a large tire which is to be removed from the wheel center. The pair of mounted wheels are picked up by the yard crane and placed upon a rigid support as indicated, then the heater ring is brought into place around the tire and the oil jets from the perforated ring ignited. A few minutes application of the heat under air pressure suffices to loosen the tire which is then slipped off of the wheel center.

PRESSURES FOR FORCING AXLES AND CRANK PINS INTO HUBS

The accompanying tables represent the practice of the New York Central lines regarding wheel fits and similar work. Table 1 gives pressures for forcing axles and crankpins into cast-iron hubs and Table 2 covers pressures for axles and crankpins forced into cast-steel or wrought-iron hubs.

These tables are based upon 8 net tons per inch of diameter of fit for maximum pressure for cast-iron hubs and 9 net tons per inch of diameter of fit for maximum pressure for cast-steel and

TABLE 1.—PRESSURES FOR FORCING AXLES, CRANKPINS, ETC., INTO CAST-IRON HUBS

Diameter of fit, inches	Minimum pressure, tons	Maximum pressure, tons	Variation of pressure, tons
2½ to 2 15/16	12	22	
3 to 3 7/16	16	26	
3½ to 3 15/16	20	30	10
4 to 4 7/16	24	34	
4½ to 4 15/16	28	38	
5 to 5 7/16	31	42	11
5½ to 5 15/16	35	46	
6 to 6 7/16	38	50	12
6½ to 6 15/16	42	54	
7 to 7 7/16	45	58	13
7½ to 7 15/16	49	62	
8 to 8 7/16	52	66	14
8½ to 8 15/16	56	70	
9 to 9 7/16	59	74	
9½ to 9 15/16	63	78	15
10 to 10 7/16	67	82	

TABLE 2.—PRESSURES FOR FORCING AXLES, CRANKPINS, ETC., INTO CAST-STEEL, OR WROUGHT-IRON HUBS

Diameter of fit, inches	Minimum pressure, tons	Maximum pressure, tons	Variation of pressure, tons
$2\frac{1}{2}$ to $2\frac{15}{16}$	15	25	
3 to $3\frac{7}{16}$	19	29	
$3\frac{1}{2}$ to $3\frac{15}{16}$	24	34	10
4 to $4\frac{7}{16}$	28	38	
$4\frac{1}{2}$ to $4\frac{15}{16}$	33	43	
5 to $5\frac{7}{16}$	36	47	11
$5\frac{1}{2}$ to $5\frac{15}{16}$	41	52	
6 to $6\frac{7}{16}$	44	56	12
$6\frac{1}{2}$ to $6\frac{15}{16}$	49	61	
7 to $7\frac{7}{16}$	52	65	13
$7\frac{1}{2}$ to $7\frac{15}{16}$	57	70	
8 to $8\frac{7}{16}$	60	74	14
$8\frac{1}{2}$ to $8\frac{15}{16}$	65	79	
9 to $9\frac{7}{16}$	68	83	
$9\frac{1}{2}$ to $9\frac{15}{16}$	73	88	15
10 to $10\frac{7}{16}$	77	92	

wrought-iron hubs. The diameter of the fit used is the mean of the two diameters given in the fit column. At least one-half of fit must require a pressure between the maximum and minimum limits of the table.

Practice in respect to such fits varies on different roads, and some shops recommend heavier pressures for driving-wheel fits than for the same diameter of fit in engine-truck and trailer wheels. In the practice of the American Locomotive Company the pressure for an 8-in. axle in a cast-steel driving wheel is from 115 to 160 tons with a preferred pressure of 128 tons; and with a 10-in. axle the pressure is from 144 to 200 tons with preferred pressure of 160 tons, thus the pressure preferred runs at 16 tons per inch of fit diameter with cast-steel wheels. With cast-iron centers the driving axles of this company are forced in under pressures from 72 to 96 tons for 8-in. and 90 to 120 tons for 10-in. diameters of fit. The preferred pressures with cast-iron centers are respectively 80 and 100 tons or 10 tons per inch of diameter. These two sizes as given are typical of the larger diameters of axle fit allowances as made by this company. For axles 6 in.

and below the pressures per inch drop to a considerably lower value. For cast-steel wheels they run down to maximum pressures of 16 tons per inch and preferred pressures of about 12 tons, and for cast-iron centers the maximum pressure is 12 tons per inch of diameter of fit, with preferred pressure of 10 tons per inch.

KEYWAY LAYOUT GAGE

It is the practice of some railroads to require that locomotive driving wheels be double keyed to the axle, the keys being located at 90 degrees. It is troublesome, however, to lay out the keyways accurately unless a gage is used.

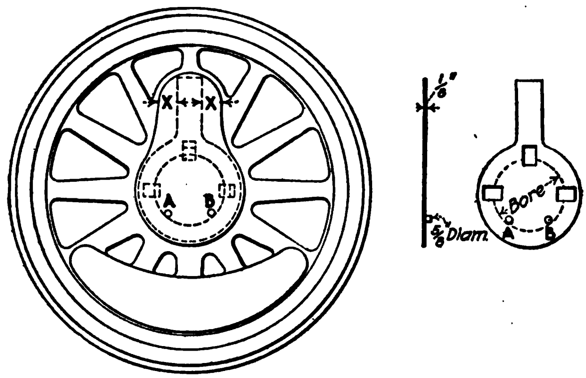


FIG. 177.—A keyway layout gage.

In Fig. 177 a gage is shown that is accurate and simple. It is described by H. E. Bilger as follows:

A plate of ⅛-in. steel is cut in the shape of a banjo. Slots of the required key width are made, one central vertically and one each on the right and left horizontally. These are made longer than necessary to give room to see the scribe marks.

Two short pins *A* and *B* are firmly placed tangent to a line representing the bore of wheel. These serve to center the gage. The neck of the banjo is made of any convenient width and central with center line of the head.

To locate the keyways the wheel is chalked, after boring and facing, and the gage laid on to bring the pins against the side of the hole. The neck is brought equi-distant from the sides of the wristpin boss, as at *X*, and the lines are then scribed.

The center and one side are used for a right-hand wheel and the center and other side for a left-hand wheel. The same idea can be used should two keys be required at any other angle.

CRANKPIN TURNING FIXTURE AT LACKAWANNA SHOPS

The half tone, Fig. 178, and the line drawing, Fig. 179, illustrate a method at the Scranton shops of the Delaware, Lackawanna & Western Railroad for truing up crankpins. The wheels are held on the machine centers as shown, the clamp *A* holding the

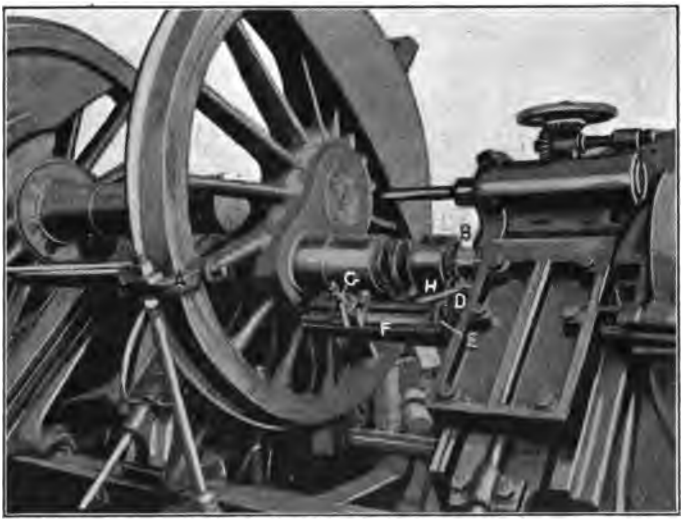


FIG. 178.—Truing up crank pins.

wheel against vibration caused by the turning tool. The gear *B*, which is attached to the spindle, is driven by the motor gear *C*. This gear drives through the intermediate gear *D* to the gear *E*. This motion drives the tool post *F* around the crankpin.

The tool is fed along the pin by means of the screw and nut shown. The handle *H* operates a clutch in the gear so that the tool may be machined. This operation may be controlled without stopping the motor. Two of these fixtures are used on the machine, one turning each crankpin.

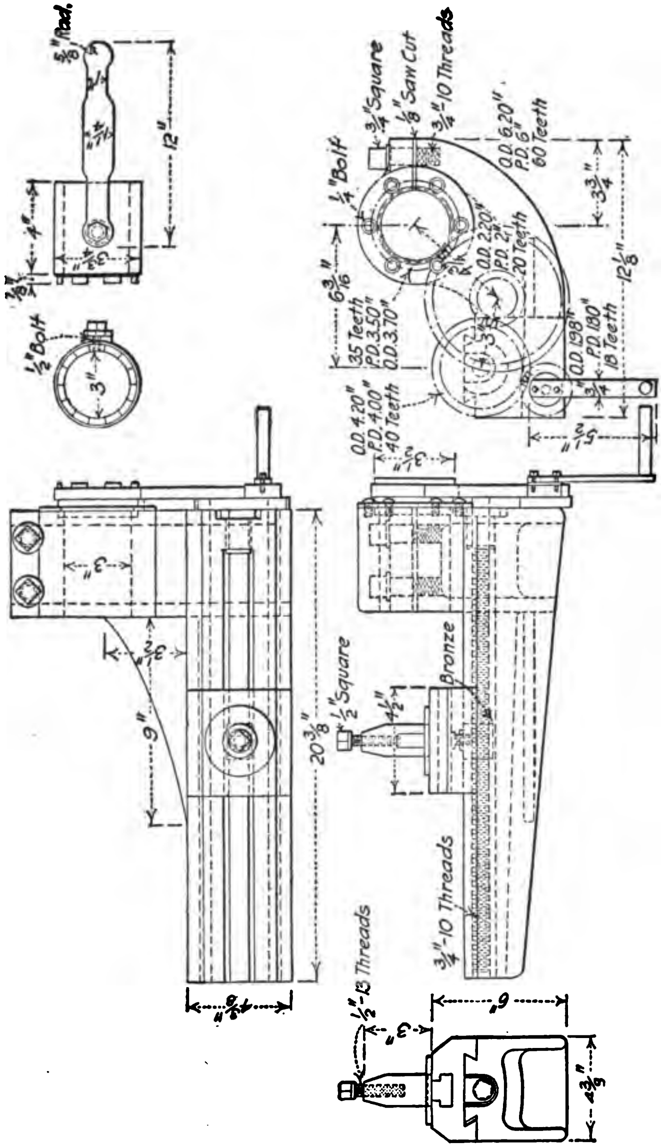


FIG. 179.—Crank turning fixture.

FITTING NEW CRANKPINS

The holes bored for crankpins in driving-wheel centers are likely to vary somewhat in diameter, one from another, and in

FIG. 180.—Measuring hole for crank pin with inside micrometers.

FIG. 181.—Finishing crank pin with roller tool.

some cases there is a considerable difference in the size of holes in a number of wheels going through the shops. The hole should

therefore be measured carefully before the pin is machined, and for this purpose an inside micrometer should be used as in Fig. 180.

In shops where the cylindrical grinder is not used the common method of finishing crankpins to size is to finish by the roller as in Fig. 181. This roller is similar to the one used for axle journals. It is in the case illustrated, 4 in. in diameter. The roll is made dead hard. The pin shown in the view is 5 in. and 6 in. in diameter on the body. The work is rotated at a speed of 60 r.p.m., the feed being at the rate of 1/16 in. advance per revolution. The depth rolled down is approximately 0.006 in.

CHAPTER XII

WHEEL SHOP EQUIPMENT AND METHODS

The wheel shop of the Minneapolis, St. Paul & Sault Ste. Marie Railway Company ("Soo" Line) at Shoreham, Minneapolis, Minn., contains many features of interest, both in connection with the arrangement of the equipment as a whole, and in the character and operation of certain special apparatus.

Two general views of the exterior of the shop are given in Figs. 182 and 183. Both of these illustrations are of importance, as they bring out, in addition to the general appearane of the shop, certain special features that go far toward making the operation of the department effective and economical.

Referring to Fig. 182, it will be seen that there is a broad platform extending past the northern face of the building, carrying a series of tracks to accommodate a large number of wheels. Alongside this platform there is a depressed track at such a level below the surface as to bring the car bodies at the same height as the platform tracks. Material to be handled in the shops is brought from the road onto this depressed spur track, whence it is transferred to the series of storage tracks along the side of the shop. Similarly, car wheels and axles that have been overhauled in the shops, and new wheels and axles, are transferred from the building and when ready for shipment are loaded on cars on this depressed spur.

HANDLING MATERIAL FROM CARS

The handling of this material to and from cars is greatly facilitated by a 5-ton gantry crane adapted to travel the full length of the building over the storage tracks and depressed siding. The crane's bridge extends from the runway along the northern wall of the shop to a point directly over the shipping track, so that axles and wheels may be picked up bodily and loaded or unloaded conveniently.

At the outer end of the gantry will be noticed a special sling, in which are shown suspended two pairs of wheels and axles.

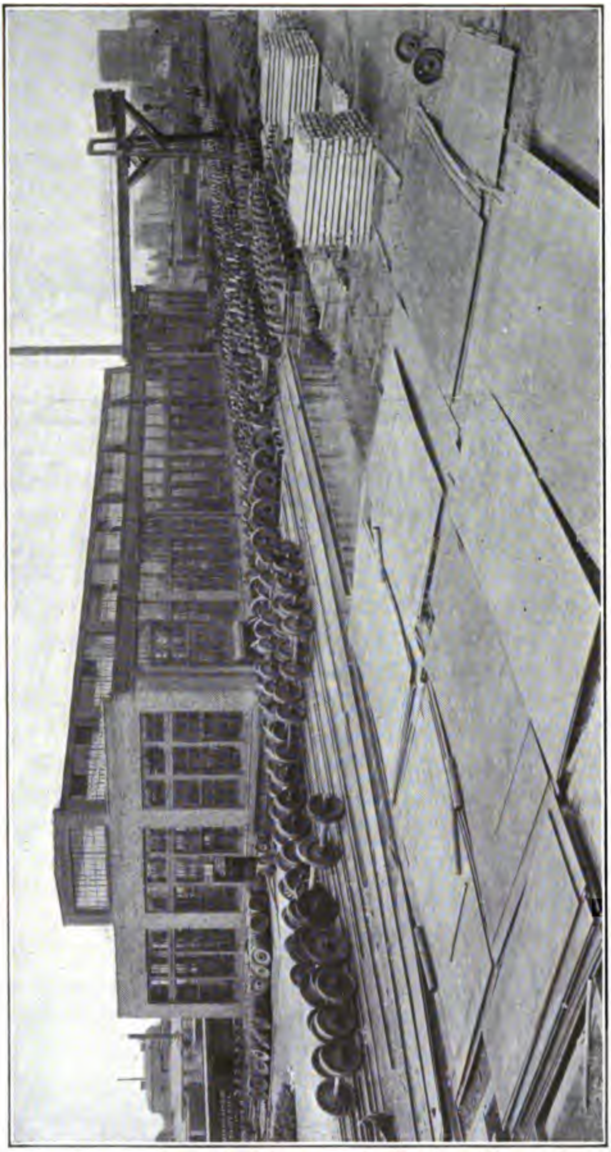


Fig. 182.—Wheel shop at Shoreham, Minneapolis, St. Paul & Sault Ste. Marie Railway Co.

Fig. 183.—Wheel shop, showing storage for unfitted wheels, axles and tires.

This sling is so constructed that it may at one time handle four axles with their wheels, holding them in exactly the same relative position that they will occupy when dropped onto the platform of the car. At the time this photograph was taken there happened to be only two sets of wheels and axles suspended from the hooks; but the open end of the sling, which ordinarily picks up four such units at once, will be clearly seen and its purpose will be understood from the explanation given.

The platform just referred to has a total width of 50 ft. At the south side of the shop there is a similar platform 40 ft. in width with a depressed spur track along its outer edge, where scrapped wheels and axles are handled and stored after they have passed through the shop. A view along the south and west walls of the building is presented in Fig. 183, giving some idea of the amount of material handled in the establishment.

BUILDING FEATURES

The building itself is 150 ft. long by 60 ft. wide with monitor the full length, and with the maximum possible amount of wall space devoted to window lights. At each end of the building at the bottom of the north wall there is a wide, low swinging door, the one at the eastern corner being clearly shown in Fig. 182. These doors are pivoted horizontally at the top and swing freely upward to allow wheels and axles to be rolled directly in and out of the shop without the necessity of having large doors of the usual type swung open to permit the passage of work. The doors are of light but substantial construction, built up of wood but sheathed on both sides with sheet metal and faced with weather strip, so that the instant a pair of wheels are rolled through, the door swings shut and closes tight, thus providing entire protection against severe weather conditions.

ARRANGEMENT OF EQUIPMENT

The interior features of construction, the arrangement of machinery and the location of tracks, cranes and trolleys are all clearly illustrated by Figs. 184 and 185. The latter is a floor plan in which the positions of all tools and handling equipment are accurately indicated. This floor plan also shows the location and proportions of the two swinging doors previously referred to.

It will be seen upon studying this plan that the machines are

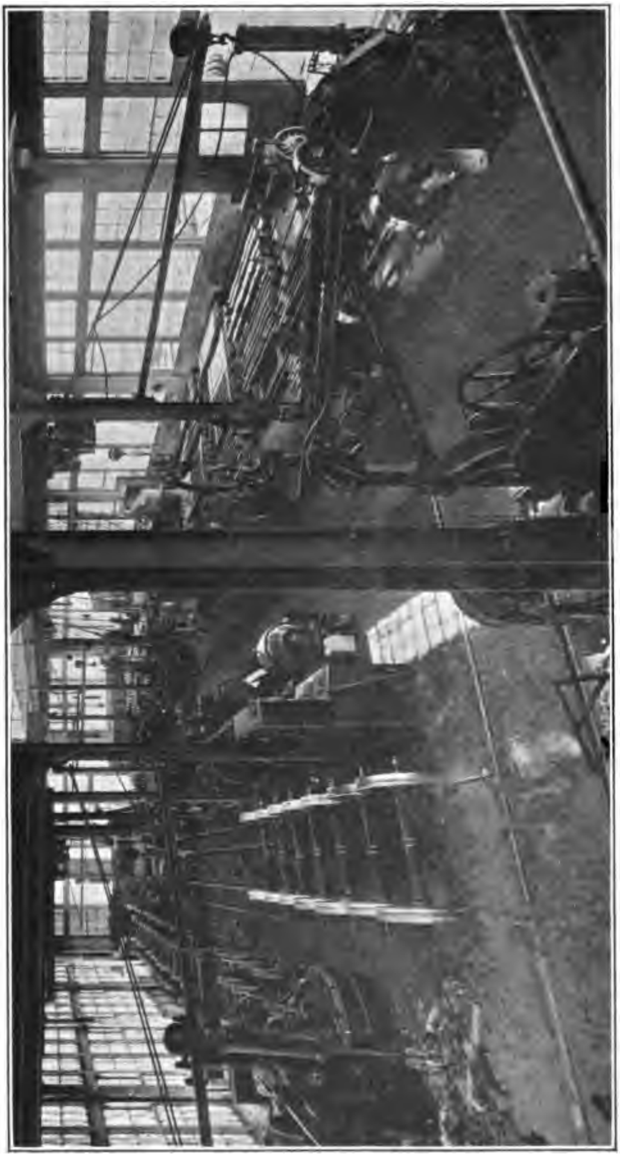


FIG. 184.—Interior of wheel shop.

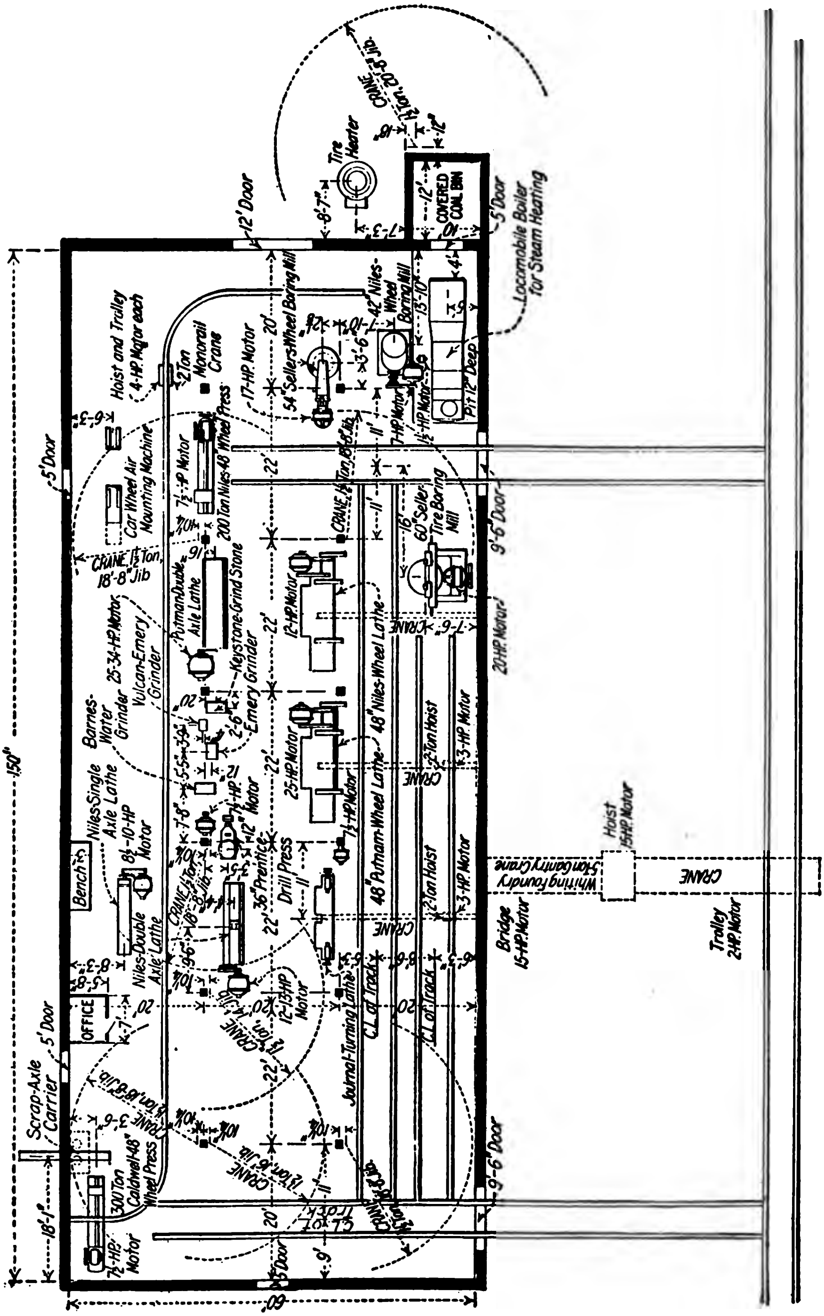


Fig. 185.—Plan of wheel shop showing machines, motors, and cranes.

all driven by individual motors, and that each machine is served by a jib crane or by a trolley that operates along a rail extending the full length of the shop at a distance of 15 ft. from the south wall. The plan view further illustrates the two cross-tracks on which material is rolled in and out of the shop, and the longitudinal tracks near the north side where wheels and axles are passed along as desired, as indicated in Fig. 184.

The wheels as rolled into the shop pass directly to the dismounting press for removal from their axles. This press is located in the southeast corner of the building directly opposite the cross track shown to the left in Fig. 185, and it has so many unique features of construction that a special description of its operation and of the method of dismounting wheels, and passing wheels and axles out of the shop, will be given in this chapter. A few of the other machines of interest, with work in operation, are illustrated in Figs. 186 to 189 inclusive.

These views are of value, illustrating as they do the methods of holding the work in the machines, the application of the tools to the cuts, and the heavy rates of feed made possible by the use of suitable machinery, adequate holding devices and proper types of tools. In certain of these illustrations the heavy cuts and coarse feeds are clearly indicated by the tool marks upon the surface of the work.

BORING TIRES AND TURNING JOURNALS

Figure 186 represents the boring of a steel tire under a two-head vertical mill where the work is gripped securely and held against possibility of chatter by clamping jaws that seize the tire by its tread and draw it down rigidly upon its seats by means of hooked clamps swinging over and acting upon the upper face of the flange. In boring out these steel tires the work is rotated at a peripheral speed of 13 ft. per minute, and the tool is operated under a 3/16-in. cut with 3/16-in. feed.

The turning of journals and the facing of hubs inside and out are two operations performed in the lathe shown in Fig. 187. This machine has four tool slides, two on each carriage, and four cuts may thus be taken simultaneously when desired. Each tool slide has independent feed, and it is thus possible to feed tools independently or in unison across hubs and over journals. At the back of the machine is suspended a convenient sling for picking up axles and wheels for placing in the lathe and for

removing the finished work. This device is in the form of a double hook on a steel A-frame with the lower ends widely spaced to balance the work properly and with the upper or supporting end hung by a spring connection from a trolley hoist overhead. This spring connection enables the sling to be swung

Fig. 186.—Boring steel tires on two-head machine.

under the axle in the lathe to take the entire load before releasing the work from the machine, without placing stress upon the machine as would be the case if a rigid sling were employed; and similarly, in putting a pair of wheels into the machine, the same advantages of a certain degree of flexibility in the apparatus are secured.

The driving of the work, it will be noticed, is by means of a belt running directly on the tread of one of the tires.

TIRE-TURNING

Tire-turning is accomplished with the equipment shown in Fig. 188, where the coarse rate of feed as evidenced by the tool marks is clearly brought out. In roughing down these steel tires the turning is done at a rate of 13 ft. per minute with a ⅜-

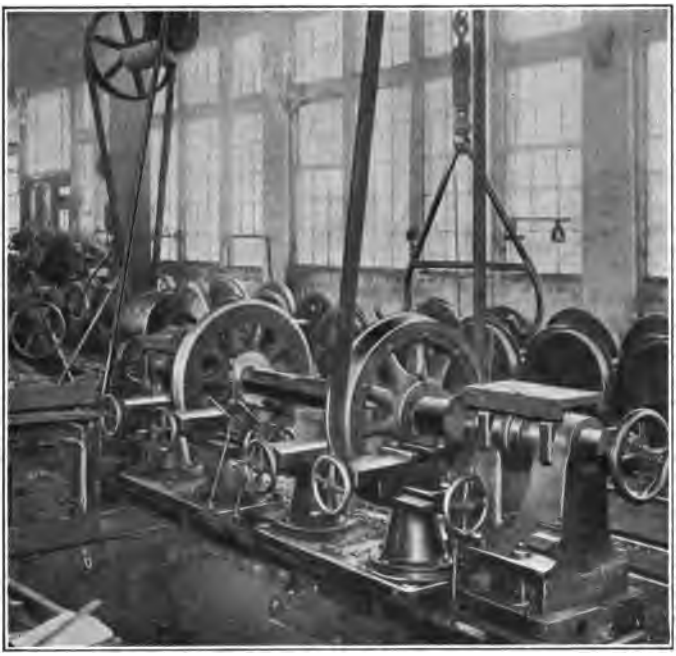


FIG. 187.—Turning journals and facing hubs with four cuts at once.

in. cut and ⅜-in. feed. The finishing is accomplished by broad-face forming tools, one of which will be seen on the cross slide at the center of the illustration. These broad facing tools, like many of the other tools used, are of Midvale steel. They are made of rectangular stock and are rigidly secured to very heavy holders. On an average 70 tires are turned to one facing of the tool. Mushet steel is used principally for axle turning.

BORING CAR WHEELS

The view, Fig. 189, illustrates the boring of car wheels and shows besides the machine tools, the facilities in the line of

cranes and special hooks for handling the work in and out of the chuck jaws. In boring hubs of cast wheels of the type here

FIG. 188.—Tire turning equipment.

FIG. 189.—Boring car wheels.

illustrated, a cutting speed of 60 ft. per minute is employed, with 0.02-in. feed and $\frac{3}{16}$-in. depth of cut.

It will be of interest to point out here that this new wheel shop soon after its completion was able with a small number of workmen, to handle regularly in the course of a month about 2,500 pairs of wheels and their axles, these including several hundred steel-tired wheels, and in addition to the machine work necessary, take care of the unloading and loading of all classes of wheels, the inspection of new and scrap material, the checking of work and all accounting that might be required in the various departments.

From this it will be understood that the work is not only well arranged, but also the handling facilities are such as to make it possible to route the work through the shop processes with little or no inconvenience or delay.

WHEEL SHOP DISMOUNTING PRESS

Reference has already been made to a novel dismounting press used in this shop for removing wheels from axles. As stated, the wheels and axles as they come from the road are rolled on cross tracks through a swinging door into the shop and passed directly to the dismounting press. Figure 190 shows several pairs of wheels passing through the horizontal doorway and rolling upon a set of tracks, which are slightly offset to permit the wheels on successive axles to clear one another and thus occupy a minimum of floor space.

The dismounting press is directly opposite the ends of the rails. To compensate for the staggered positions of the different sets of wheels and axles, each unit, consisting of an axle and a pair of wheels, as it passes off of the track rolls onto a platform which has a transverse movement sufficient to bring the inner hub of each left-hand wheel into line with the left-hand face of the supporting yoke of the press.

This travel of the platform, which represents a movement of about 16 or 18 in. is accomplished through the medium of an air cylinder and piston below the shop floor.

The control is effected by means of suitable valves operated by a narrow strip of steel resting on the floor plate above, so that as a pair of wheels roll forward and pass over the controlling strip the platform is moved laterally to carry wheels and axles to a definite position in line with the press yoke.

The rails have a slight inclination downward toward the press, enabling the wheels to be rolled forward with slight effort. As

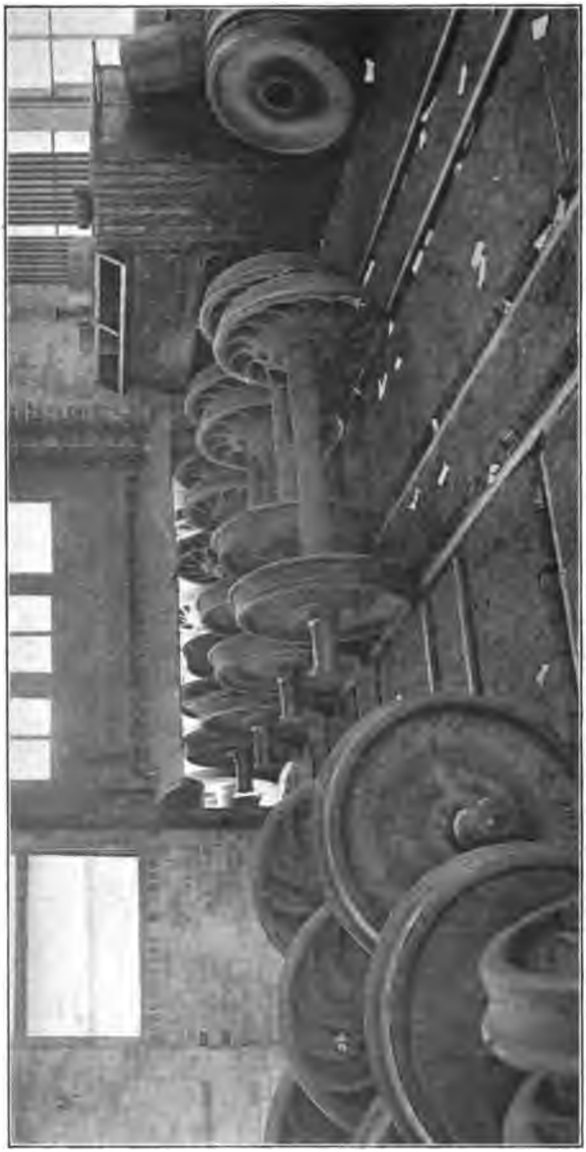


FIG. 190.—Car wheels ready for dismounting.

the wheels approach the press, the flange of the left-hand wheel contacts with the inner face of a narrow bar of steel secured to the floor at a slight angle in the horizontal plane, causing the inner face of the hub to run forward snugly against the opposing face of the press yoke. This is illustrated clearly in Fig. 191, where a pair of wheels on their axle ready for dismounting are shown in position in the press with the projecting wheel resting upon a narrow platform which has a longitudinal movement in an opening in the floor, so that this wheel will always be properly supported during the process of forcing the axle out of the other wheel. It constitutes really a floating table which travels back and forth as required to accommodate the wheels and which is always on a level with the shop floor to permit the wheel to roll on and off freely. To take different sizes of wheels, the entire press is adjustable vertically by four screws at the outer corners, the screws being rotated in unison by a power-driven chain passing over four sprockets, one on each screw.

RAM HEAD AND AXLE SUPPORT

In order that there shall be no cramping of the work or unnecessary stress upon the ram, due to distortion of the axle or to irregularity of its face, the ram is provided with a flexible head, Fig. 192. This consists of a hemispherical member with a flanged base by which it is attached to the end of the ram, and it carries upon its body a spherically seated member attached to the base by a ball-ended spring-controlled bolt. This arrangement permits the working face of the device to swivel in any direction whatsoever, so that its steel faceplate may always rest squarely against the end of the axle, obviating all possibility of cramping or binding when pressure is applied to the ram.

In line with the axle at its opposite end there is a long air cylinder with a piston rod that carries a pair of very heavy spring-controlled hooks for grasping the outer end of the axle immediately behind the journal flange. This pair of hooked jaws is supported by a suspending member having at its upper end a trolley wheel running on a bar extending forward to the top of the press. The arrangement is quite clearly shown in Fig. 191 and a detail of the jaws and trolley support is given in Fig. 193.

The effect of the trolley support is to hold the hooked jaws

Fig. 191.—The dismounting press.

closely in line with the end of the axle, thus at the same time taking their weight from the outer end of the piston rod, which

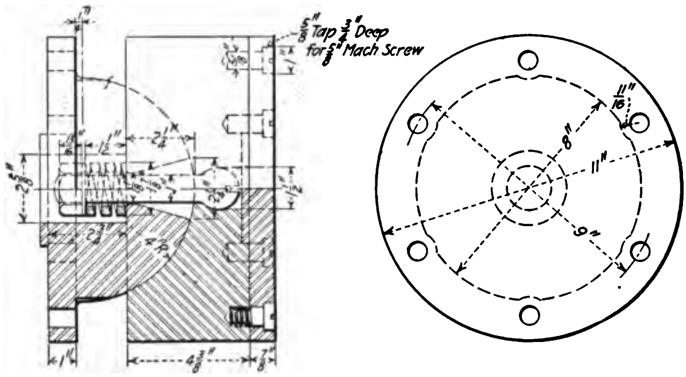


FIG. 192.—Special head for press.

in its extended position projects several feet from the air cylinder. The outer end of the upper jaw is kept from dropping below normal position by a hinged supporting link at A, and the lower jaw is similarly controlled by the spring B. This spring operating upon the rear ends of the jaws closes the working ends sufficiently so that as they slide forward over the axle flange they snap down upon the axle body and provide a substantial grip immediately inside of the flange, as indicated by the sketch. In this position they are clearly represented by Fig. 194.

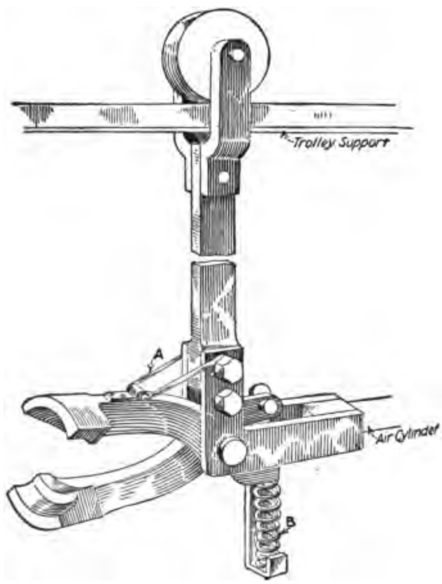


FIG. 193.—Hooks for axle ends.

As the axle is pressed out of the wheel hub, the air piston is operated to draw the axle and the remaining wheel away from the press as in Fig. 195. Here, as will be seen, the carriage under the wheel has travelled to the right with the work, while the

other end of the axle is supported by a spring-suspended sling mounted upon the top bar of the press and adjustable by hand-

Fig. 194.—Application of the hooks.

Fig. 195.—Axle support with the first wheel dismounted.

wheel and screw to bring the supporting roller to the necessary height to carry the end of the axle properly.

The next step in the dismounting process is to roll the dismounted wheel to an air hoist at the back of the press, where it is lifted into line with an inclined chute down which the wheel rolls to a car alongside the platform back of the shop.

DETAILS OF HOIST AND CHUTE

The hoist is shown in Fig. 196. In normal position it rests with its carrier—a narrow, inclined metal box open at the ends—level with the floor. When a wheel is rolled into the carrier,

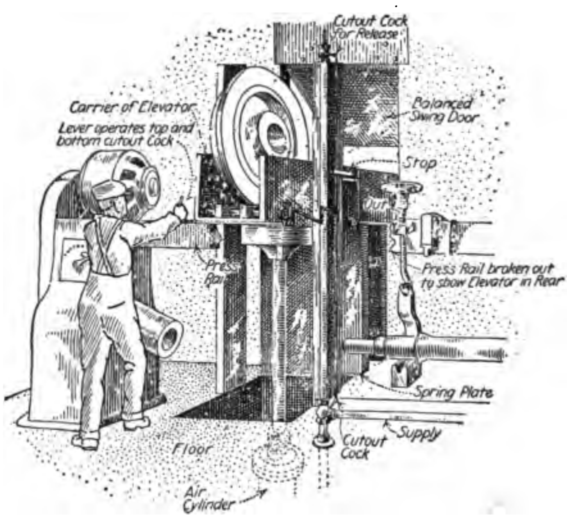


FIG. 196.—Apparatus for lifting scrapped wheels.

the rear of the wheel flange rests against a spring plate bolted to the inner face of the shop wall. When the lever on the press rail is operated, a stop on the vertical rod at the rear actuates the cut-out cocks that control the piston, and the carrier and wheels are elevated into line with the inner end of the chute, as seen in Fig. 196. The wheel then rolls out through an opening in the wall which is normally closed by a balanced swing door, and passes down the chute. The carrier is then lowered to original position ready for the next wheel.

The construction of the inclined chute is shown in Fig. 197. Here, as will be noticed, the chute is made up of steel plates, properly spaced and tied together at the bottom by through bolts, these bolts carrying also a pair of rails made of rectangular

stock, which are spaced and secured by sections of ¾-in. pipe. As the wheel rolls down the chute on one of the rails, it is in-

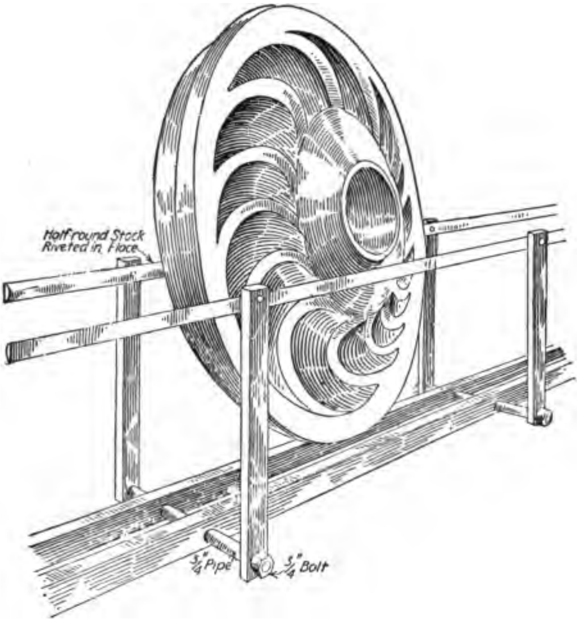


Fig. 197.—Chute for scrapped wheels.

Fig. 198.—Rolling the axle around into position for dismounting the second wheel.

clined slightly and rests in its travel against a half round bar rivetted to the upper edge of the chute.

With the first wheel out of the way as described, the remaining wheel on the axle is rolled around, as in Fig. 198; the long air piston at the right is advanced to grasp the axle end and the second wheel is dismounted, as shown in Fig. 199. An air hoist on a crane jib is then swung over the center of the axle, as illustrated in Fig. 199. The axle is grasped bodily by the tongs on the air-lift and is then passed out of the shop on a special carrier, or if it is to be returned at once and put into service it is placed on a pile at the rear of the lathe.

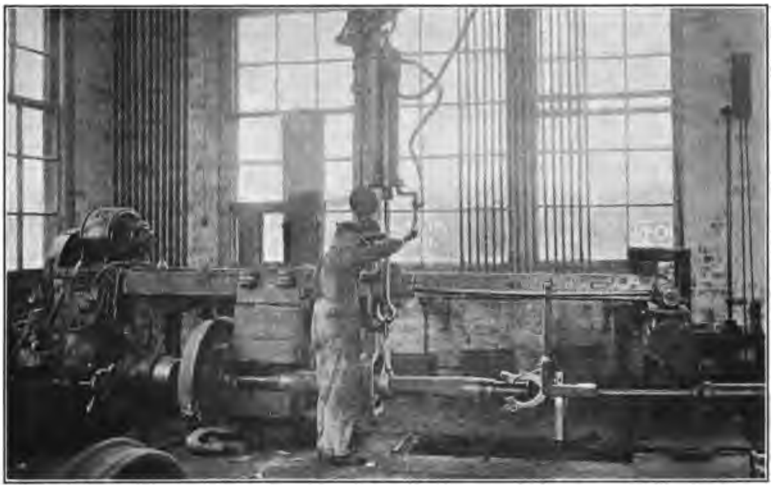


FIG. 199.—Removing free axle from the press.

THE CARRIER FOR THE AXLES

The axle carrier just referred to as used for removing the axles to the storage piles on the platform outside the wheel shop, is operated on a track located at the right-hand end of the dismounting press. Its general features of construction and operation will be understood from Figs. 200, 201 and 202 herewith.

Referring to Fig. 200, the carrier is shown at the inner end of its track with an axle in place ready to be run out through the opening in the shop wall and dropped on one of the axle-piles on the storage platform outside. The axles on this platform are classified and piled up according to size and condition. Before each axle is run out on the carrier, it is inspected and marked to

indicate the respective point at which it is to be dumped from its cradle.

In the process of dismounting wheels from their axles a good many of the latter are simply swung around on the jib crane over the press and deposited behind the axle lathes, for refitting at once for service. A great many more, however, are passed immediately out of the shop and onto the storage piles referred to.

The carrier itself consists of a four-wheeled steel truck carrying above its platform a pair of arc-shaped cradles, which normally are in the position shown in Fig. 200 for holding the axle. Underneath the platform there is a set of wedge-shaped members that are adapted to slide longitudinally to tilt the cradles in either direction for the purpose of discharging the axle either to the right-hand or the left-hand side of the carrier. This wedge-shaped controlling device, when in the position indicated in Fig. 200, holds both cradle members in a horizontal position so that the axle rests securely in place until the cradles are automatically tilted after the carrier has been run out along its track to a predetermined point for the discharging of the axle.

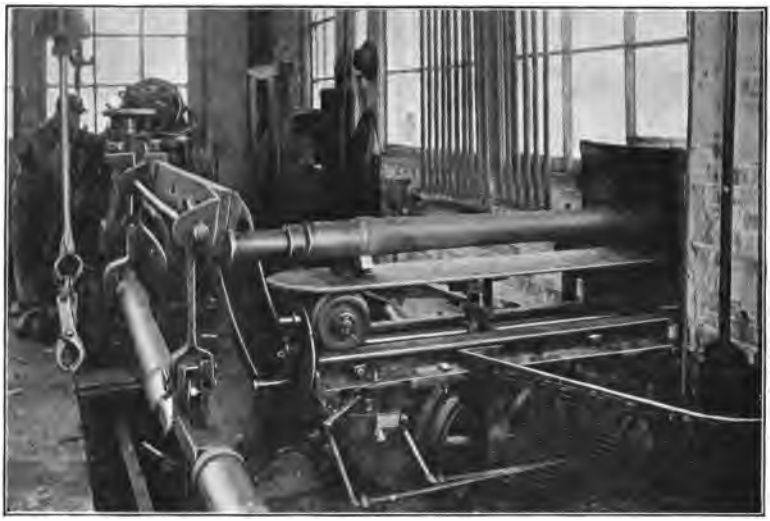


FIG. 200.—Axle carrier in wheel shop.

OPERATION OF CARRIER

The truck, or carrier, is drawn along its track by a wire cable passing over drums beneath the ends of the track. The opera-

tion of the driving drum, and hence of the carrier itself, is effected by a long-stroke cylinder and piston with suitable gear and cable connections for giving the desired length of travel and the requisite rate of speed for the carrier.

Between the tracks upon which the carrier is operated there extends the full length a controlling shaft operated by the crank handle shown at the front of the vertical disk mounted at the inner end of the track. This controller shaft carries a series of dogs or stop collars, one of which is located immediately above each pile of axles on the storage platform. Each of these con-

Fig. 201.—The carrier run out on its track.

troller dogs carries a projecting lug, which, when the controlling shaft is turned to a certain position, is adapted to engage the wedge mechanism under the platform of the carrier track and tilt the cradles to dump the axle at that point. When the operator of the dismounting press drops an axle upon the carrier, he sets the controlling crank handle to the proper notch on the disk mentioned above and pulls the valve lever. The carrier is then drawn out past a swinging balance door over the opening in the shop wall and passes along the track until it reaches one of the stop dogs, which has been set into operative position by the turning of the crank handle.

Figure 201 shows the carrier and an axle run well out on the track and immediately over the pile of axles upon which the axle on the carrier is to be dropped. Figure 202 represents the carrier at the instant following the tilting of the cradle and the dumping of the axle. The operator now moves the valve lever at the inner end of the track, and the carriage runs back into the shop. There, at the end of its return travel, the cradle mechanism comes in contact with a fixed dog that draws the wedges into position to throw both cradle holders into horizontal place for receiving the next axle.

FIG. 202.—Carrier cradle tilted and axle discharged.

As will be noticed, this apparatus eliminates entirely all laborious handling of axles and accomplishes its results with little loss of time or effort upon the part of the machine operator.

HANDLING WORK IN THE LATHE

The axle-turning lathes stand near the dismounting press. One of these lathes, with work piled up at its rear, is shown in Fig. 203. This view illustrates the convenient sling, trolley and jib for handling axles in and out of the lathe. It also shows the supporting rest beneath for facilitating the handling of the work

and brings out clearly the method of dogging and driving the axle in the machine. The dog, it will be observed, is in ring form and is attached to the body of the axle to clear the journal. The two-point driver is made with correspondingly long projections to extend past the journal and contact with the lugs on the dog. This lathe, like all other tools in the shop, is driven by an independent motor.

As rapidly as the axles have been inspected and turned, when required, they are classified by diameter and placed on the floor conveniently for the wheel borer. After the fitting of the wheels

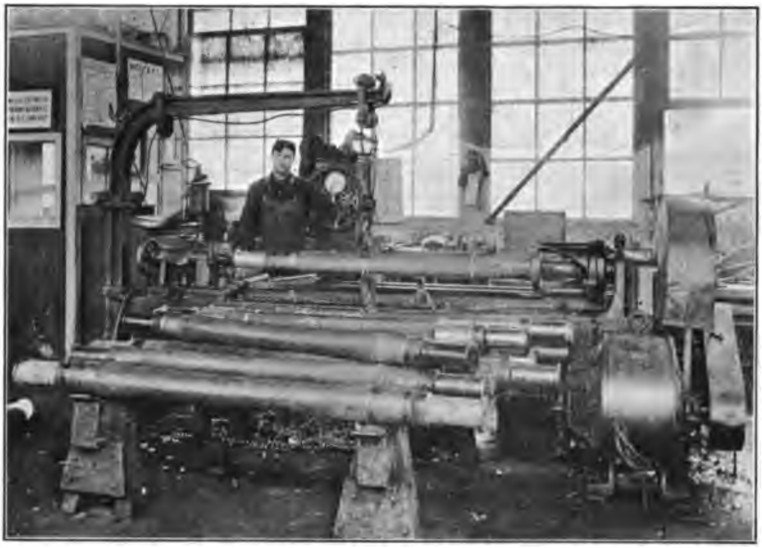


Fig. 203.—Turning axles.

has been accomplished, the axles and wheels are assembled in the mounting press, Fig. 204. This press is located at the far end of the shop from the dismounting press. Like the latter, it has a cross track for receiving the mounted units so that they may be rolled out of the shop through the horizontally swinging door that keeps the passageway closed except at the moment when wheels are rolling through.

ASSEMBLING AND MOUNTING PRESS

The assembling and mounting press consists really of two distinct machines, the assembling section being air operated

through mechanism controlled by the valves seen in the foreground of Fig. 204. Here two wheels will be noticed, one at either side, ready for the insertion of the axle, which is shown suspended from the pneumatic hoist. The two wheels are shown held in upright position by spring clamps. The wheel at the left is secured against a fixed head, while the one at the right is clamped to a head that travels longitudinally under the action of an air cylinder controlled by the fourway cock attached to the stand halfway between the wheels, where the operator may readily guide the axle and attend to the operation of the machine.

FIG. 204.—The assembling and mounting press.

Both heads on this assembling press consist of ½-in. steel plate placed in upright position and mounted on a pair of 5-in. I-beams. This press starts the wheels true on their bearings on the axle and proves a most convenient and effective piece of apparatus for assembling preparatory to the forcing of the wheels into position.

The hydraulic mounting press, seen at the rear in Fig. 204, is located at a sufficient distance from the assembling apparatus to permit five pairs of wheels to stand in the intervening space. The mounting press is fitted with special jaws on the outboard housing. The ram head carries a distance piece of C-section, open along one side, so that after the wheels have been rolled into the press and properly mounted upon the axles, the open

block may be rotated on its seat on the press ram and the wheels and axles rolled freely out of the press, ready to be run out of the shop. The removal of the work from the press is further facilitated by a pneumatic plunger in the outboard housing, which forces the wheels and axle bodily into definite line with the track. This air plunger also makes it easy to admit a filler block to lift the near wheel off the housing when it is necessary to force the other wheel a little farther onto the axle.

HEATING TIRES

For removing and replacing the tires of wheels there is a fuel-oil heater that enables one man, with the aid of a jib crane, to handle all this work. The horizontal heater is lined with fire-brick in a cast-iron body, and one lever controls the operation of all covers. Following the heating of one tire, the apparatus is automatically lighted from the heat of the bricks. As the tire expands from the heating action of the flame, the wheel falls through to a truck below, which is then pulled out and later returned empty for the next wheel. While a new tire is heated and placed on the wheel, another wheel is being made ready for heating, so that the process is practically continuous. The operation of completing the wheel requires about 6 min. only.

In a day of 9 hr. an average of 125 tires, say 40-in., can be removed, and fully half that number of new tires can be heated in the one machine.

MORE DATA ON TURNING AND BURNISHING TOOLS FOR AXLES

The illustrations, Figs. 205 to 211, show the tools and gages used by the Pennsylvania Railroad shops in turning wheel fits and journals. The cutting tools are represented in Figs. 205 to 209. As described by Joseph K. Long, the tools in Fig. 205 are right- and left-hand for journals from 5 by 9 to 6 by 11 in. Figure 206 shows the tools for 4¼ by 8-in. journals; Fig. 207 for 4⅛ by 8-in., and for special "foreign" journals 4½ by 8-in. In Fig. 208 is shown the size of tool for the 3¾ by 7-in. journal, while Fig. 209 shows an offset tool. The cutting end of this tool is made the same as the right-hand tools seen in preceding illustrations.

The straight tools are made in pairs, right- and left-hand, for use in double-end axle lathes, while the offset tools are for use in

large gap axle lathes. In the latter the axle is put on with both wheels in place, to have the journals trued, and it is generally necessary to have an offset tool for the purpose.

The cutting speed may be from 70 to 90 ft. per minute, and rolling can be done at the same speed. The feed for both is from $1/32$ to $1/16$ in. per revolution. The depth of cut varies with the wear on journal. If it is $3/32$ in. or over, two cuts should be

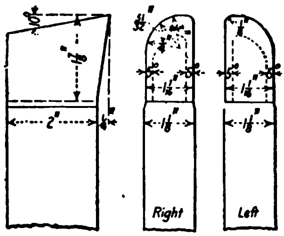


Fig. 205.

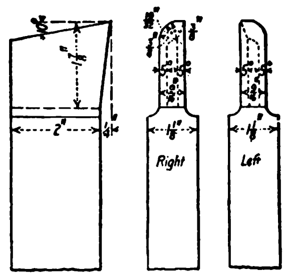


Fig. 208.

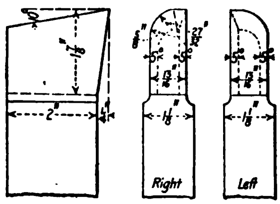


Fig. 206.

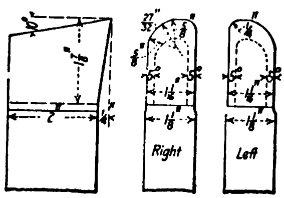


Fig. 207.

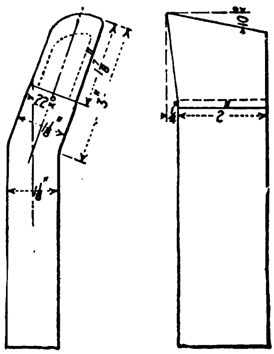


Fig. 209.

Various cutting tools.

taken, one heavy and one light. The rollers should be well oiled on the rolling surface while being used.

The amount of metal to be left for burnishing depends on the finish of the last cut. When this is fairly smooth, $1/32$ in. is usually sufficient. Rolling surfaces should be set perfectly square with the axle. The proper fillets should also be given each side of the roller hub to avoid cracks developing either in hardening or in use. Both the cutting tools and rollers should be made of a high-grade tool steel.

DETAILS OF ROLLERS

The rolling, or burnishing, tools are shown in Fig. 210. Both of these tools fit into the same holder, which is shown at *A;* the spindle is illustrated at *B* and the washers at *C* and *D*. The spindle is of tool steel, hardened and ground. The washers *C* are also of tool steel, hardened and ground, one being placed at each end of the burnishing roller, while the outside washer *D* is made of axle steel, as it merely forms a seat for the nut. The

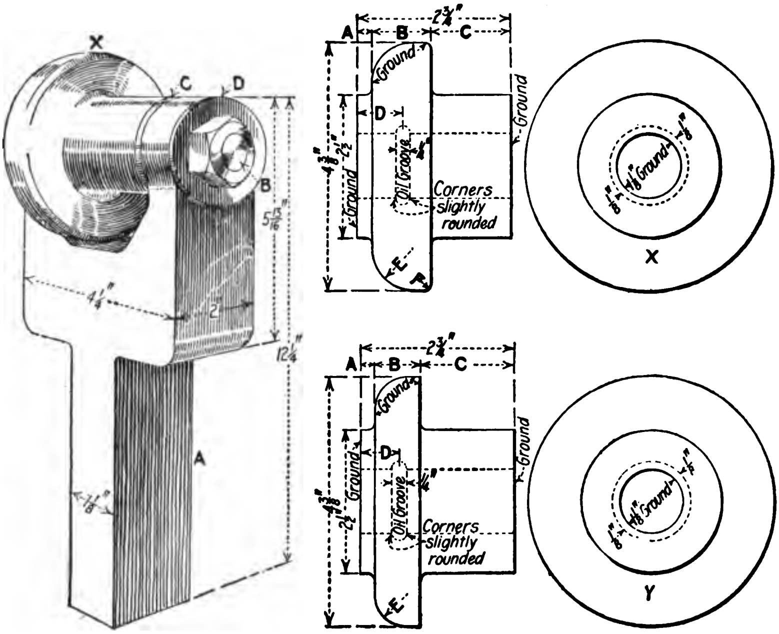


Fig. 210.—The burnishing tools.

rollers *X* and *Y* are made of tool steel, hardened, and ground out for the spindle bearing and also on the outer curved face, as shown. The oil grooves in both the roller and the spindle are clearly shown. The table of sizes gives the dimensions of the rollers for different axles and also for both single- and double-ended lathes.

THE GAGES

The gages form an important part of the whole method and are shown in Fig. 211. They are made of $\frac{3}{32}$-in. tool steel and are hardened and ground. The outside corner gages the fillets

on the different sizes of axles stamped on each gage. The inside corner, or curve, shows the shape to which the tool to be used is ground. This is not a duplicate of the radius of the journal, as can be seen by the difference between the solid and dotted lines. The space between these lines shows the amount of metal to be left by the tool for final rolling by the burnishing tool, already shown. The center gage is for testing the lathe centers and the

TABLE OF ROLLER SIZES

	No.	A, In.	B, In.	C, In.	D, In.	E, In.	F, In.
X........	1	3/4	1 1/16	1 7/16	13/16	[illegible]	1/2
X........	2	3/4	1 1/16	1 7/16	13/16	[illegible]	1/4
Y........	3	3/4	11/16	1 11/16	11/16	[illegible]	[illegible]
Y........	4	3/4	9/16	1 13/16	11/16	[illegible]	.....
X........	5	7/8	1 1/16	1 1/16	1 3/16	[illegible]	....
X........	6	7/8	1 1/16	1 1/16	1 3/16	[illegible]	[illegible]
Y........	7	13/16	13/16	1 1/8	1 1/4	[illegible]	....
Y........	8	1 1/16	9/16	1 1/8	1 5/16	[illegible]	....

Numbers 1 and 5 for 5x9 in., 5¼x9 in., 5½x10 in., 5½x11 in. and 6x11-in. journals. Numbers 2 and 6 for 4¼x8 in., and special foreign 4½x8-in. journals. Numbers 4 and 8 for 3¾x7-in. journals.

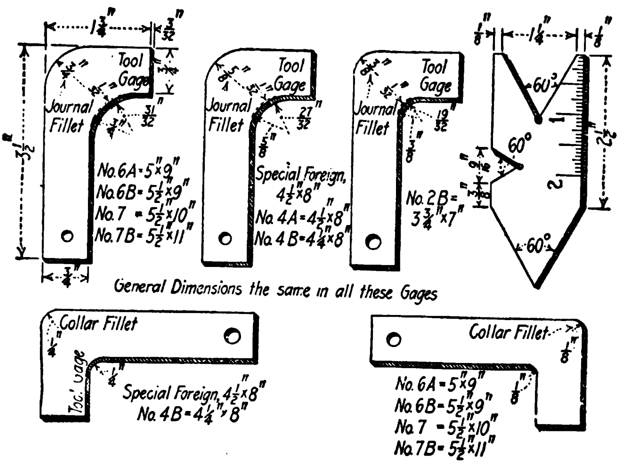


FIG. 211.—Special gages.

centers in the axles. It is of the usual type, but is made longer and heavier for convenience in handling.

PRESSURES FOR MOUNTING CAR WHEELS

The practice of the Pittsburgh & Lake Erie road in regard to mounting pressures for car wheels and axles should be of value and interest in this chapter on the work of different wheel shops. This company states that they have found quite a variation in the necessary allowances to make proper fits, depending upon

the grade of metal in the wheels. Their experience shows that if they apply their wheels to the different diameters of wheel seats, within the limits of their standard pressures, the following allowances are satisfactory:

Wheels from 50,000 to 80,000 lb. capacity require an allowance of from 0.004 to 0.006 in.

Wheels of 80,000 and 100,000 lb. capacity require an allowance of from 0.006 to 0.008 in.

They also find that the same allowance is satisfactory for both cast-iron and rolled-steel wheels, although this allowance applies to the steel wheels at higher pressure.

The following is a list of pressures at which they apply their wheels:

50,000 capacity or less, cast iron, not less than 30 tons or over 50 tons—steel, 45 to 55 tons.

60,000 capacity or less, cast iron, not less than 35 tons or over 45 tons—steel, 55 to 65 tons.

80,000 capacity or less, cast iron, not less than 45 tons or over 60 tons—steel, 56 to 80 tons.

100,000 capacity or less, cast iron, not less than 50 tons or over 65 tons—steel, 70 to 85 tons.

CHAPTER XIII

MACHINING AND GRINDING IN PIPE JOINTS AND OTHER PARTS

The half tone, Fig. 212, illustrates a type of ball-joint reamer for steam-pipe work for locomotives, this form of tool being shown in several different sizes in the group photograph, while the line drawing, Fig. 213, gives details of the construction as made in the 7-in. size.

The reamer is made up with a soft-steel body and high-steel blades which are inserted in milled slots in the body and calked

FIG. 212.—Ball joint reamers.

in place. The body is bored out and threaded and a Morse taper shank is threaded at the body end to screw tightly into place. The taper shank is formed with a liberal shoulder which sets up squarely against a seat faced out in the soft steel body.

The slots are ½ in. wide and are cut at an angle of 55 degrees to the vertical so that the included angle would be 110 degrees. The method of cutting the blades from the bars of stock is shown

in detail in Fig. 214 at the bottom of the drawing. The ends, front and rear, are cut off at a 55-degree angle so that practically no metal is wasted except for the saw kerf and the small corner at the rear end which is milled away in squaring off the heel of the blade.

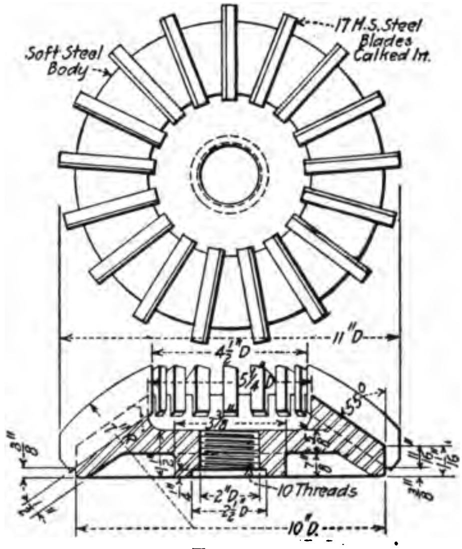


FIG. 213.

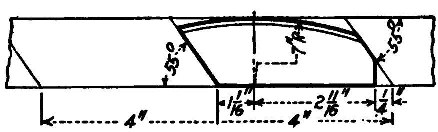


FIG. 214.

FIXTURE FOR GRINDING THE BALL-JOINT REAMER

A fixture for grinding radius or spherical reamers of the type illustrated in Figs. 212 and 213 is shown in Fig. 215. This device is used on the table of the grinding machine and consists of a swivelling head carrying a spindle which receives the ball reamer to be sharpened. The upper swivel plate carries a tooth rest against which the reamer teeth are brought in succession for grinding to radius. The swivelling action of the fixture carries the edge of the blade past the wheel in an arc of the required radius and brings all teeth to uniform outline.

One of these reamers is seen in Fig. 216 in operation on a dry pipe. The work is done under a big radial drill with the pipe supported under the tool by means of its flange and the outer end carried upon suitable levelling blocks.

FIG. 215.—Fixture for grinding spherical reamers.

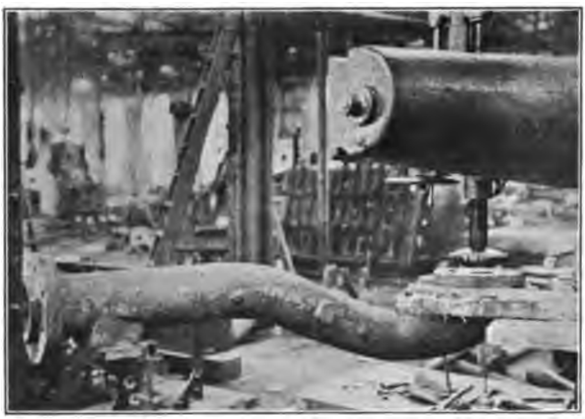


FIG. 216.—Ball reamer operating in dry pipe.

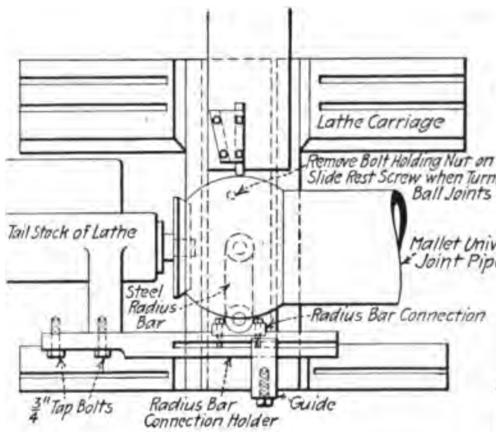
BALL-TURNING ATTACHMENT FOR THE LATHE

Another interesting device is the radius attachment, Fig. 217, for turning such work as a Mallet universal joint pipe. Other interesting features in connection with this equipment include an expanding form of chuck for holding the inner end of the pipe,

and a double tool holder. The chuck is attached to the face-plate of a 42-in. lathe and consists of a flanged cylindrical body in which are three jaws adapted to be radially expanded by means of a cone-shaped center plug which is operated by a draw-in bolt.

The outer end of the pipe (the ball end) to be machined, is carried on a large cone center mounted upon the tailstock center. The large cone surface is cleared at three points in its circumference leaving a three-point bearing to receive the work.

The attachment for the ball-turning work, is made up principally of the radius bar connection holder, which is bolted to the back of the head stock; the radius bar connection which is



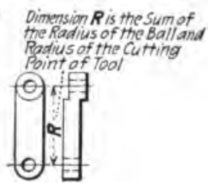


FIG. 217. FIG. 218.

bolted to the face of the connection holder; the radius bar which is pivoted to the connection and attached to the tool slide; the radius bar pin and the guide. All parts are of steel.

The radius bar connection holder projects out over the rear of the carriage where it is engaged by the guide which is bolted to the rear edge of the carriage. The connection holder is 3 in. wide by 1½ in. thick and it is provided with a ¾ by ½-in. groove which fits a tongue on the outer arm of the guide. Thus as the carriage moves along either to right or left, the connection holder is firmly supported and cannot be sprung out of line by the action of the radius bar in operating the tool slide upon the carriage.

There is a supporting gib under the opening in the guide. The method of attaching the radius bar will be understood from the sketch. The radius bar connection carries a stud which has a body fitting the hole in the rear end of the radius bar, while the front end of the radius bar fits over a similar body on a pin which is tapped into the cross slide of the carriage. The nut for the regular slide rest screw is of course released by removing its holding screw so that the slide may move freely under the action of the radius bar.

The plan view in the sketch, Fig. 217, shows the work set up with round-ended tool exactly on the centerline of the radius bar when the latter is at right angles to the lathe centerline, or in its fully extended position. When the carriage is fed along the work, the rear end of the radius bar being fixed must pivot about its pin and the front end of the bar must then draw the tool slide and tool back or toward the work. The feeding motion of the carriage thus produces a movement of the turning tool in the path of a circle and brings the end of the pipe to spherical form. The radius bar, it will be noticed in Fig. 218, is made with a distance between centers equal to the sum of the radius of the ball end to be turned and the radius of the cutting point of the tool. All of the tools and methods in the above illustrations are from the Southern Pacific shops at Sacramento.

OSCILLATING MACHINE FOR GRINDING-IN PIPE

The appliance in Fig. 219 was constructed for grinding dry-pipes into flue sheets. The rotary motion of the air-drill spindle is transmitted by an eccentric to a rocker arm which oscillates a horizontal shaft extending inward to the pipe and carrying three radially placed pointed jack-screws which are set up tight inside the mouth of the pipe. The screw points engage the pipe hard enough to cause the latter to turn to and fro with the oscillations of the rock shaft and the pipe is thus ground in to a tight seat in the sheet. Here an air motor is mounted horizontally and the entire outfit is carried by a broad plate across the top of the shell. Numerous slots in the carrier allow the necessary adjustments to be made to suit the work. The slotted rocker arm is usually given a throw of about 20 degrees although this is varied to suit conditions.

Fig. 219.—Fixture for grinding in dry pipe.

Fig. 220.—Grinding in steam pipe joints by hand.

GRINDING-IN PIPE JOINTS BY HAND

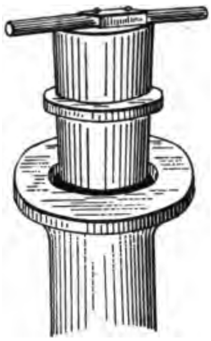


FIG. 221.—Outfit for grinding in pipe joints.

Figure 220 represents the grinding-in of steam-pipe joints with a hand-operated wooden plug which is worked back and forth to allow the abrasive to act upon the ring and pipe surfaces. The sketch of the plug and ring joint in Fig. 221 shows the manner in which the plug is piloted in the mouth of the pipe and made to serve as a guide for the ring. For a 6-in. plug like the one shown, the length is about 8 in. The body of the plug is somewhat tapered so that it will fit into the ring and hold it while it is being worked back and forth by the handle during the grinding-in operation.

OPERATIONS ON PIPE FLANGES

A method of threading pipe flanges is shown in Fig. 222 where a threading tool in the form of a pipe tap is used on the turret lathe so that after the facing of the work and boring to internal diameter the threading is done with the edge of one of the tap lands, this acting as a chaser.

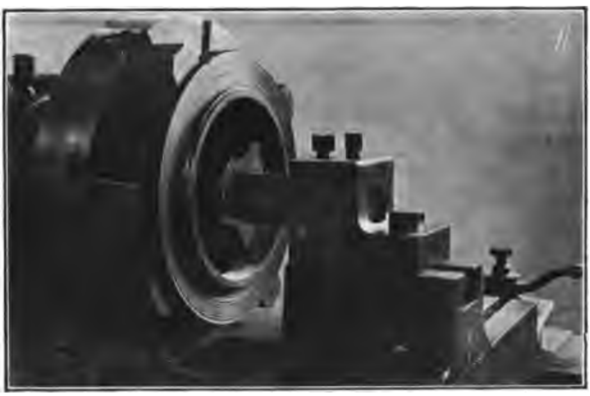


FIG. 222.—Threading pipe flange in turret lathe.

THROTTLE WORK

The throttle box to be seated is located in the drill press and a double tool then run down to form a new surface for the valve to

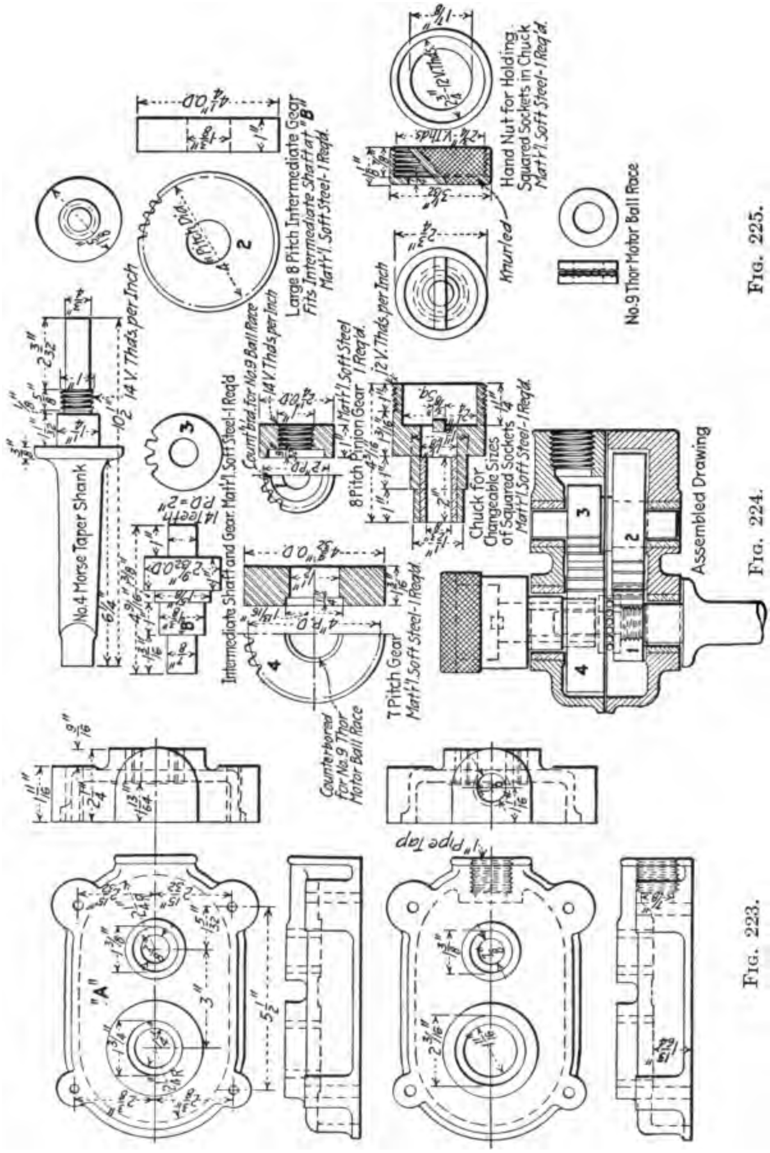


FIG. 223.

FIG. 224.

FIG. 225.

Speed reducer for motors

seat upon. The two bevel cutters are accurately spaced by an intervening collar to finish both seats in the throttle box at the proper distance apart. Both cutter heads are provided with rectangular openings in which facing cutters may be placed so that when the bevel cutters have eventually worked below the upper faces of the valve seat the flat faces may be surfaced off. This prevents a seat from ever becoming so deep that the valve drops below the conical surface and becomes improperly seated.

The valves are ground by means of a universal drive from an air motor carried by an "old man" on the bench. The grinding mixture is placed in the joint and the motor does the rest, the valve being lifted at intervals to start at another point in the grinding-in of the seat.

A SPEED REDUCER FOR DRIVING TOOLS

In connection with the use of various classes of large and medium-sized tools used in the way of drilling, tapping, seating and other operations, the speed reducer for motors shown in the drawing Figs. 223 to 225 should be of interest. This device is shown as made at the Southern Pacific shops and all details are given in the drawing. The assembled mechanism is shown by Fig. 223, the various steel details in Fig. 224 and the casing details in Fig. 225. The gearing gives a four-to-one speed reduction. The method of construction will be understood without detailed explanation.

CHAPTER XIV

BRASS TOOLS FOR LOCOMOTIVE VALVES AND FITTINGS

The brass department of the railroad shop carries on many lines of work of importance and interest. The present chapter covers details of tools and operations in connection with the machining of brass fittings of various kinds, which are typical of the numerous classes of parts coming under the heading of check valves, oil-feed cocks, blow-off cocks, water-gage fittings, cylinder-drain cocks and so on.

WORK ON OIL-FEED COCKS

The view, Fig. 226, of one of the benches in the brass room of a railroad shop, shows a number of oil-feed cocks assembled.

FIG. 226.—Brass work for locomotives.

One of these oil-feed cocks is shown complete in Fig. 227 and the tools for all parts are reproduced in Figs. 228 and 229.

In Fig. 228 *A* is the body of the valve and *B* the taper plug. The operations on the body are performed with the casting held in special chuck jaws, but the plug is turned on the lathe centers. The taper hole in the body is produced with the two reamers *C* and *D*, Figs. 228 and 229. The reamer *C* is made with two 5/16-in. blades inserted in a solid taper body 1½ in. in diameter at the small end, or ⅝ in. under the blade diameter. The inserted blades are formed near the rear ends to bore out the 3⅛-in.

diameter for tapping to 3¼ in., and to face off the end of the work for the guide for the stem. Reamer *D*, which is the finishing reamer, is made with two plain taper blades inserted in a taper body which carries at opposite sides a pair of fiber strips, as

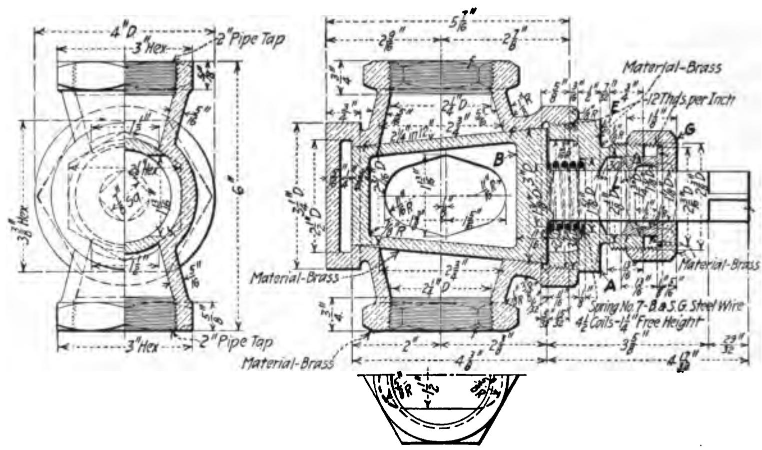


Fig. 227.—Oil feed cock.

indicated, to steady the reamer in the hole and prevent it from chattering.

The guide *E* for the valve stem is bored in front for the 1⅛-in. stem, chambered out to 1¾ in. and formed with the 30-degree seat for the packing by means of the boring cutters in the tool *F*,

Fig. 228.—Brass lathe tools for oil feed cocks.

which carries also a turning tool for machining the outside of the neck to 2⅜ in. for threading to receive the nut *G*. The same combination toolholder carries a crosswise cutter for facing the outer end of the stem guide to length. The 1⅝-in. chamber for

the end of the spring in the front of member *E* is bored out by the combination tool *H* carrying a cutter of that length in front, a ⅞-in. facing cutter further back and a turning tool at *I* for the large diameter that is afterward to be threaded. The pilot of toolholder *H* is 1⅛ in. in diameter, which is the size of the hole bored in an earlier cut by the tool in the outer end of holder *F*.

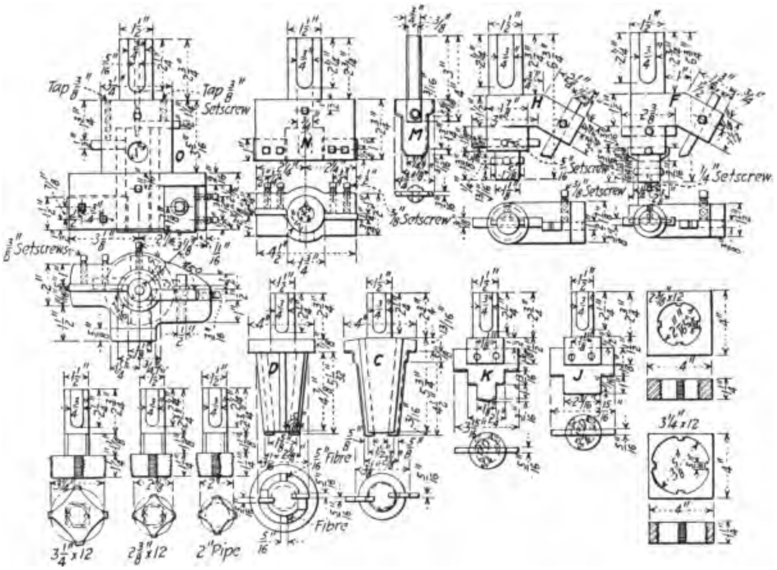


Fig. 229.—Tools for oil feed cocks.

CHAMBERING AND FACING

The nut *G* is bored out, chambered and faced at the inner side by the tools *J* and *K*, the latter establishing the depth of chamber for the gland. The gland *L* is bored and faced to an angle of 30 degrees by the tool *M* in the holder *N*, and the outside turned to a diameter of 1¾ in. by the flat cutters in the sides of the box tool *N*, these also facing the shoulder of the gland. The box tool at *O* is used for turning the stem of the plug *B* and for facing the end off to length; also for putting in a center and countersinking it.

The various taps and dies in the view referred to are readily identified with the threads they are used for producing.

BOILER CHECK VALVES

Another piece of work made in quantities is the boiler check valve for locomotive injectors illustrated in section and ele-

vation in Fig. 230. This is another case where special chuck jaws are a great convenience in holding the main casting while performing various operations in the lathe, the body of the valve having a spherical form with connections leading off at right angles to each other.

BORING AND REAMING TOOLS

Referring to Fig. 231 the tool *B* is used for boring the hole in the top of the valve body for the cap *C*, Fig. 230, and for boring the chamber under the valve seat and forming the seat *D* for the cap; the same tool also drills the valve-stem hole. The latter is done with a $\frac{33}{64}$-in. twist drill carried in the end of

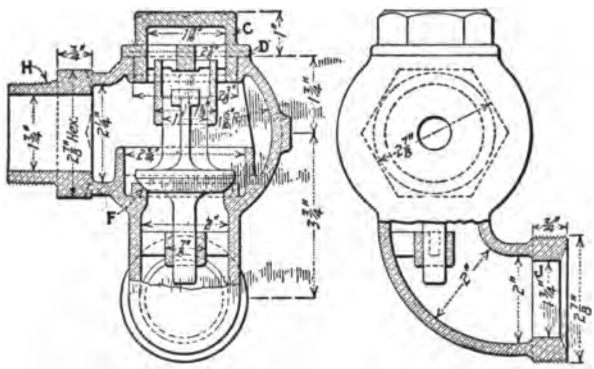


FIG. 230.—Boiler check valve.

the boring bar. A cutter $1\frac{3}{4}$ in. long bores the neck for the valve chamber and another cutter $2\frac{19}{64}$ in. across bores the hole in the top of the body for the threading for the cap. The same bar carries the 4-in. cutter for facing off thes eat for the cap.

A second tool of similar proportions is shown at *E*, Fig. 231, for forming the valve seat at *F*, Fig. 230. This cutter is $2\frac{1}{4}$ in. in diameter and the seating tool is formed with 19 teeth. The outer end of the bar is provided with a $\frac{1}{2}$-in. pilot threaded on its enlarged shank and screwed into the end of the bar. The pilot is guided in the hole drilled in the lower part of the valve body for the valve stem. The tap for threading the top of the body for the cap is shown at *F*.

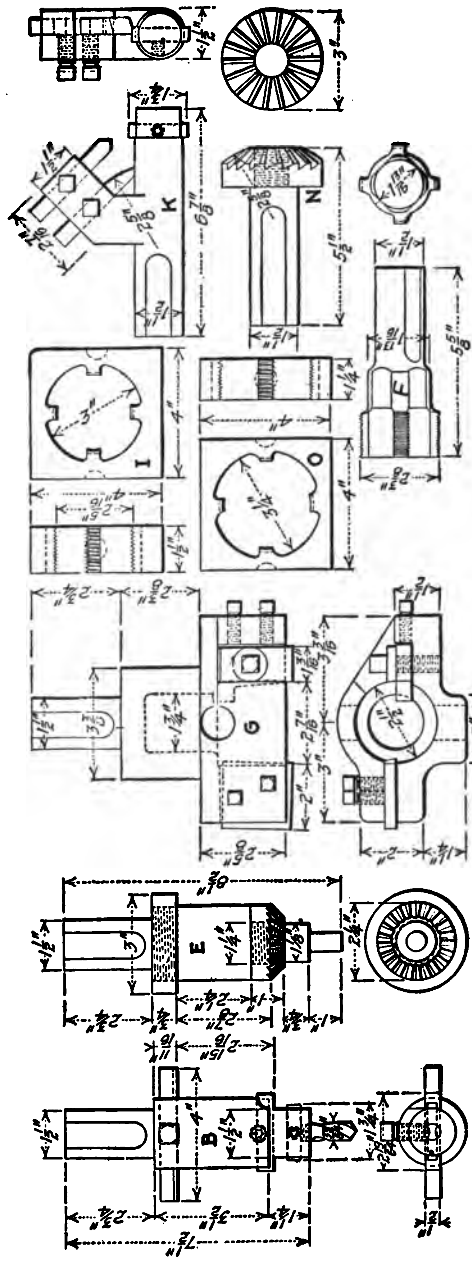


FIG. 231.—Details of check valve tools.

FINISHING THE PIPE CONNECTION

At *G*, Fig. 231, is shown a box tool that is utilized for turning and facing the 2-in. pipe connection *H* at the side of the valve, Fig. 230. The broad-faced cutters are set at an angle in the holder corresponding to the taper of the pipe thread, and the inner end of one of these cutters has a projecting lip to form and finish the outer end of the connection. The die at the side at *I* is for threading this connection.

BALL-JOINT TOOLS

The ball-joint connection at *J*, Fig. 230, is first bored, turned and faced to a radius by means of the tool *K*, Fig. 231, which carries a 1¾-in. boring cutter near the outer end, a turning tool for sizing the outside for the thread at *L*, and another tool at *M* for roughing out the ball seat to a radius of 2⅝ in. These two tools are placed at an angle so that they can be readily adjusted to hold the work to the required diameter and depth of radius.

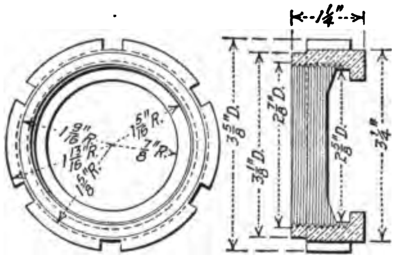


FIG. 232.—Coupling for an injector pipe.

The finishing tool for the spherical seat is shown at *N*, Fig. 231. It is a solid tool cut with 18 teeth, all to the radius of 2⅝ in., and secured to the shank by a threaded end on the latter. The die for threading the joint for the coupling is shown at *O*.

The coupling nut is shown by the detail, Fig. 232. It merely requires threading internally, and the tap for this purpose is shown in the engraving.

FINISHING VALVES AND CAPS

The box tools used for turning the two ends of the brass casting which forms the valve are shown in detail in Fig. 233.

The tool at *R*, Fig. 233, is for turning the winged end, or spindle, of the valve, facing off the outer end, and turning the outside diameter of the valve disk itself. The next tool *S* is for facing off the side of the valve, turning the stem to ½-in. diameter and forming a seating surface to an angle of 45 degrees. The cutter which does the turning and facing of the under side of the

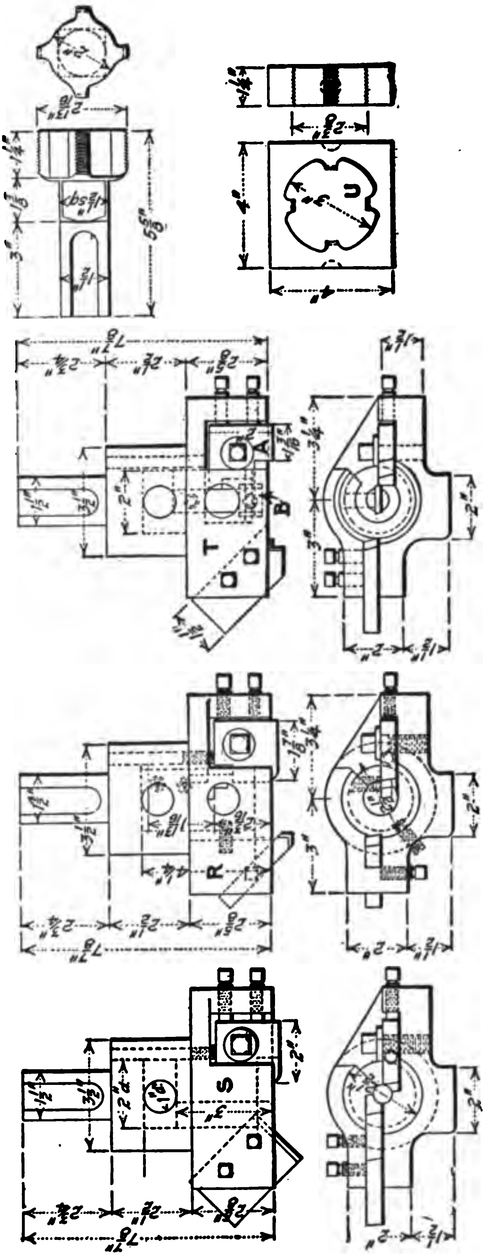


Fig. 233.—Tools for check valves and caps.

valve is a broad-faced tool with a 3/8-in. round corner to produce the fillet in the stem.

THE VALVE-CAP TOOLS

The box tool at *T*, Fig. 233, is for machining the valve-guide cap *C*, Fig. 230. In this box tool the cutter *A*, which has three shoulders, accomplishes the turning and facing of the pilot on the valve-guide cap, which has a diameter of 1 3/8 in. and it also turns the body for threading to a diameter of 2 3/8 in., at the same time facing the under side of the flange on the cap. Simultaneously with the outside turning operations the inside of the cap is bored out to a diameter of 1 in. by the cutter *B*, which is carried in a round shank inserted in the center of the tool as represented.

The die at *U*, Fig. 233, is for threading the lower end of the cap. The tap above is for tapping out the ball-joint cap.

OPERATIONS ON BLOW-OFF COCKS

In the illustrations a complete outfit of tools is shown for machining the various members of a standard blow-off cock, details of which are given in Fig. 234. Details of all of these tools with dimensions are shown in Figs. 235 and 236.

Referring to Fig. 234, the drawing of the valve shows it in its wrought-iron yoke, but all other parts, unless otherwise specified are of brass.

HOLDING THE WORK

Work of this character is held for first operations in special chuck jaws which enable the casting to be machined at one end so that further operations may be attended to with the work located and held by finished surfaces.

When two ends of a valve body require machining and threading in line the work may be held on a swivelling chuck fixture or adapted to swivel on a faceplate knee to present one end after the other to the same kind of tools; or, if preferred, the end first finished may be used for screwing up and so locating on a faceplate fixture or spindle plug which will assure the opposite end coming in alignment when machined. The method of holding in the chuck after the first operation depends upon the quantity to be machined at one time, or upon the special requirements of the particular piece of work in hand. Blow-off cocks are here made

in relatively large quantities, and the brass shop is consequently fitted up with a large variety of special chuck jaws, adaptors, and numerous special fixtures. With a job like this machined first on the face which receives the valve-guide cap *B*, all other ends may be attended to by using the finished end for cap *B* as a locating medium for securing the work in a fixture on which it can be swivelled from one end to the other or placed in any required position with the simplest holding fixtures.

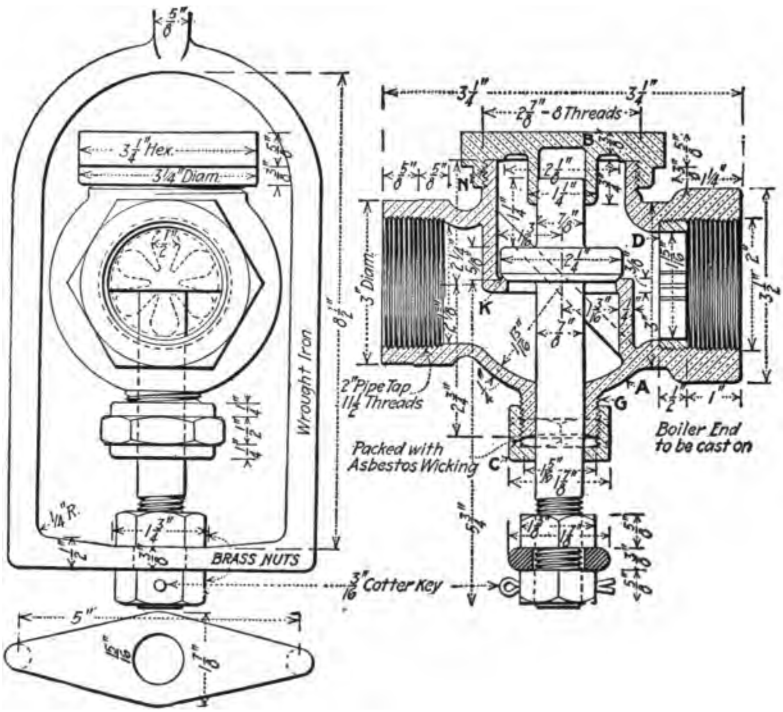


FIG. 234.—Blow-off cock.

BORING AND FACING TOOLS

The flat drill, or reamer, and the tap for the 2-in. pipe connections at the ends of the valve body are shown at *E*, Fig. 235. Both facing cutters in tools *E* and *F* have considerable working surface to cover, and by carrying the work of boring or reaming out the cored hole on a solid four-lipped tool and using an inserted facing blade, a much stiffer construction is secured and the upkeep

of the tools correspondingly simplified. Furthermore, the operation is smoother and less liable to result in chatter.

These tools, like the others that follow, are carried in the turret and the shanks are all made to a standard size for fitting directly in the turret holes or in adaptors of holders.

Before the valve seat can be machined, the valve-stem packing nipple *G*, Fig. 234, is finished with the tools *H*, Fig. 236, and a reamer for sizing the hole. This allows the valve-seat tool to be properly piloted when it is later put into use from the opposite side of the valve body.

The drilling and turning tool *H* is in the form of an open box or wing tool, carrying a drill at the center and two cutting tools in the angular wing at the side. The first tool turns the nipple to threading size, and the second rounds off the end. The two cutters are readily adjusted in respect to the drill and both are held securely by headless set screws, which are used in practically all of the tools of similar type, giving a very neat and safe arrangement. The slots for the tools are cut out of the solid metal and the cutters are a close fit so that all parts are securely held when the set screws are tightened.

THREADING DIES

The dies for threading the various portions of the valve are of square outline and used in a square-pocketed holder into which they are readily slipped as required.

The threading die for the nipple above referred to is seen at *I*, Fig. 235. As the outside of the die is only 3 in. square, while the holder socket is large enough to receive the 4-in. dies required for other threading operations on the valve, a square ring adapter is provided to carry the smaller die.

These dies being for brass work are all made with narrow lands, ranging from $\frac{1}{4}$ in. for the $1\frac{7}{16}$-in. size to $\frac{3}{8}$ in. for the larger sizes. The lands are practically central as laid out, leaving the front edge half the thickness of the land ahead of the radial center line but with the cutting face finished to radial lines.

The tools for finishing the valve seat *K*, Fig. 234, are shown at *L*, Fig. 236. The tool body is formed with a pilot to enter the reamed hole in the valve-stem nipple and carries in addition to the angular face cutter *M* for the valve seat a turning tool *N* for sizing the outside of the cap nipple for the thread and a facing tool *O* for finishing the end of the nipple.

The flat cutter *M* bores out the metal in the cored opening under the valve seat, finishes the valve seat to the angle required

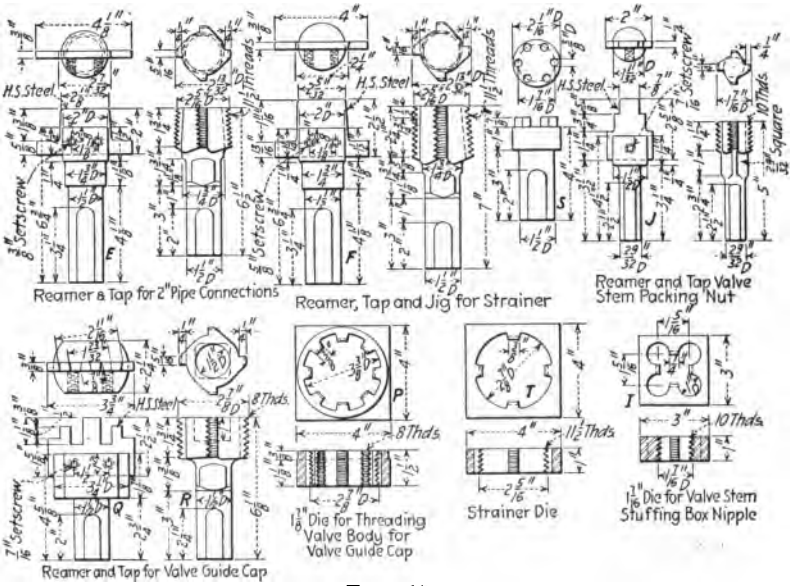


FIG. 235.

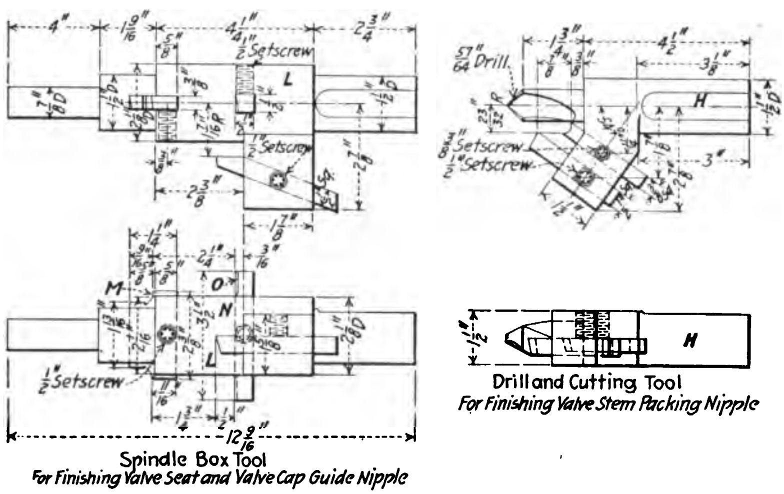


FIG. 236.—Tools for blow-off cocks.

and faces the top of the seat, the pilot on the end of the body guiding the tool during the process, assuring alignment with the valve-stem guide.

The cutter *N* for sizing the valve-cap nipple is placed at an angle to the axis of the toolholder to provide for any adjustment required in maintaining the diameter of the work. The facing cutter *O* is fixed crosswise of the body and holds a definite position in relation to the valve-seating cutter.

The die for cutting the 2⅞-in. thread on the valve for the guide cap is shown at *P*, Fig. 235.

The valve-guide cap *B*, Fig. 234, has a central blind chamber formed in the projecting boss on the inner face. This is the opening that guides the valve spindle on that side of the seat.

This brass casting is machined with the tools in Fig. 235, where *Q* is the flat cutter for reaming out the hole and for turning the bore for the thread and for facing the bottom of the cap. The flat cutter *Q* is of high-speed steel. It is of proper contour to finish the surfaces as required and to clear the metal where no finish is necessary. It bores out the shell of the cap and is followed by the tap *R*. This tap is in the form of a shell at the end to provide a clearance chamber which enables the tap to be run down over the projecting hub in the cap and so reach the shallow wall around the outside which has to be tapped.

The strainer seen in place at *D*, Fig. 234, is a narrow disk cored with six openings and threaded externally to fit the bottom of the tapped connection which is made for 2-in. pipe. The device made for holding this in the lathe while it is turned and threaded is shown at *S*, Fig. 235. It is a short arbor with six pins in its face adapted to receive the thin casting and drive it for the machining cuts. The die, which is run on while it is thus held, is at *T*, Fig. 235.

There is in the group one other fitting that may be referred to as the valve-stem packing nut *C*. The tools for boring and tapping are represented at *U*, Fig. 235. They require little description. The single flat cutter performs the service of boring out the hole and chamber in the nut and facing it at the same time.

The valve stems, which are cast in the form shown in Fig. 237, are finished with the tools at the top of the group and shown with their dimensions in Fig. 238. Both box tools are made with cast-iron bodies and have cutting tools back and front.

The first operation tool to the left, Fig. 237, is for the short end of the stem, the work being chucked by the long end for this process. The inverted tool is placed at an angle to allow

for adjustment in turning the valve diameter, and the flat, broad-faced cutter is adjustable by means of two screws to hold

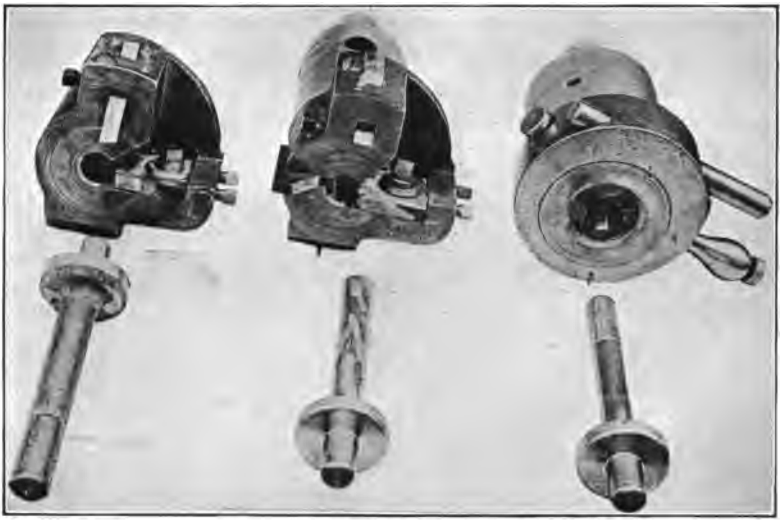


Fig. 237.—Box tools for turning valve stems for blow-off cocks.

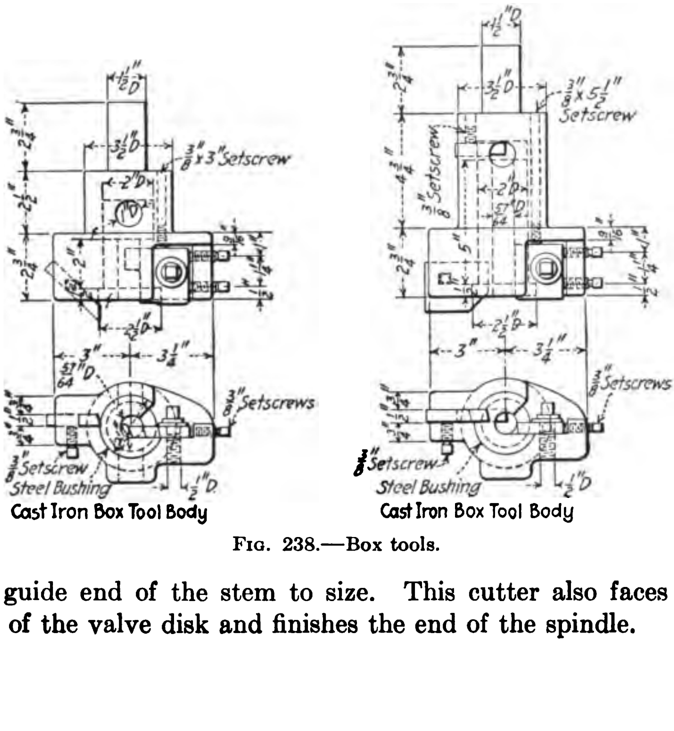


Fig. 238.—Box tools.

the guide end of the stem to size. This cutter also faces the side of the valve disk and finishes the end of the spindle.

The work is then reversed and the long spindle turned. The box tool for this has two flat cutters for sizing the stem and finishing the other face of the disk, and at the rear of the body is inserted a square tool for squaring off the end of the work to length and preparing it for threading by the opening die.

HAND TOOLS FOR FINISHING AND REPAIRS

The tools in Fig. 239 are for repairing the valve seats and valves when worn. The seating-tool spindle *A* carries two cutters as required, one *B*, for facing off the flat surface surrounding the valve seat, the other, *C*, for operating in the valve seat itself.

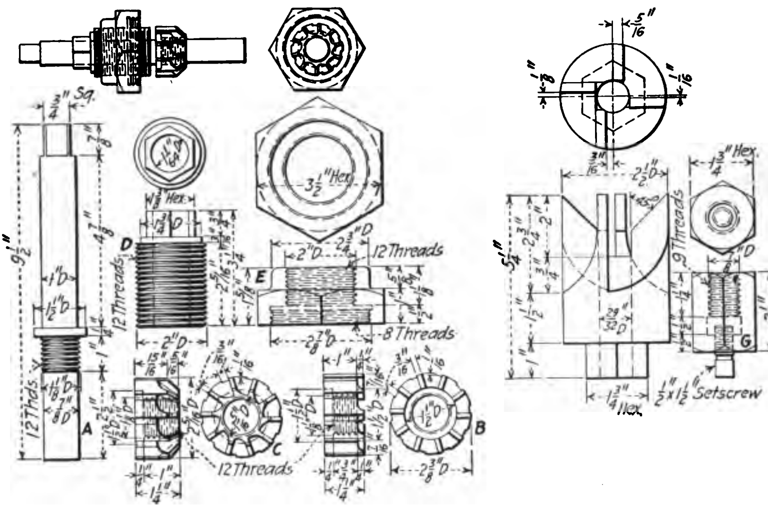


Fig. 239. Valve-seat tools.

They are threaded internally to fit the thread on the spindle and seat up against the shoulder behind the thread. The spindle fits in the threaded sleeve *D*, which in turn fits the nut *E*, and when the appliance is assembled and put into place the nut *E* is screwed onto the job in place of the regular guide cap and allows the cutting tool to be adjusted to the work by operation of the squared projecting end of sleeve *D*.

The hollow mill at the right in Fig. 239 is for touching up the angular surface on the valve, the cutting portions of the tool being bevelled to 45 degrees. The hollow mill is slipped on over the stem and then the backing up device *G* is screwed on behind

the mill. This carries a set screw which enables the operator to readily adjust the tool to the cut by simply setting up the screw and so forcing the mill forward or drawing back the work, which to all purposes amounts to the same thing.

HOSE NOZZLES

A very complete set of tools for another brass job is shown in Figs. 240 and 241. They are for machining the hose nozzle shown, with its various fittings, in Fig. 240, where the nozzle body is seen at *A*, the taper plug at *B*, the washer at *C*, the nut for the plug at *D*, the tip or nose of the nozzle at *E*.

FIG. 240.—Hose nozzle parts and tools.

Machining the nozzle body involves facing the large end and boring out and tapping for the connection; turning the small end and threading for the nose or tip; taper-reaming the hole for the plug and facing the metal around the ends of the hole.

The flat-boring or reaming cutter for machining the large end of the body is shown at *F*, Figs. 240 and 241, and the tap at *G*. The flat cutter is 5/16-in. stock secured in a plain shank for the turret and has two boring sizes, one for the small hole leading into the body of the nozzle, the other for the tapping size. The wide face of the cutter takes care of the facing of the end of the body at the same time that the holes are bored.

The small end of the body is turned with the box tool *H*, which is made up of a two-winged holder carrying a pair of flat tools which fit in slots planed out in the positions indicated so that

the edges of the cutters are in alignment for working uniformly on the shoulders of the nozzle.

The cutters turn the size for the threading of the end, turn the shoulder and face it, and face the small outer end of the body. The thread is made by running on the square die, *I*, which cuts a 1⅛-in. by 14 per inch thread.

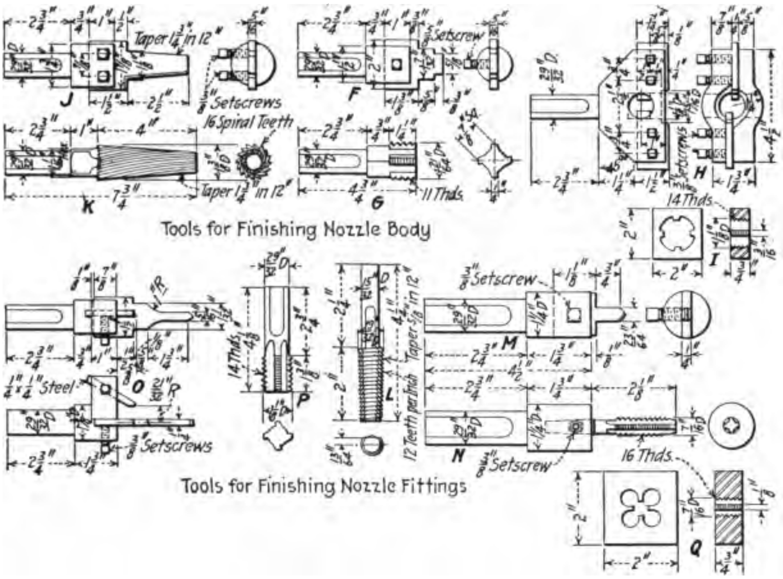


Fig. 241.—Hose nozzle tools.

THE TAPER HOLE

For the taper hole, which is 1⅛ in. at the large end and tapers 1¾ in. per foot, the reamers *J* and *K* are applied, the nozzle being gripped in special chuck jaws which hold it squarely with the taper portion in line with the lathe centerline. The roughing reamer *J* bores out the cored hole to the required taper and faces the end. The spiral finishing reamer *K* then merely smoothes out the hole. The latter reamer is made with 16 flutes cut on a left-hand spiral to prevent it from feeding too rapidly into the work.

The taper plug is finished by turning on centers in the lathe and is eventually ground into its seat in the nozzle body. Its washer at *C* is finished internally with a flat at one side of the hole to keep it from turning on its bearing, by means of a broach *L* which is cut with a buttress thread of 12 to the inch, so that it looks like

a taper tap before it is flatted on one side. It is made to a taper of 5/8 in. per foot, and the cutting portion is 2 in. long. With this taper and pitch of broaching teeth the increase in size from one tooth to the next is equal to about 0.004 in. and the total taper from point to large end of broach is 0.104 in. The broach thus having a sheared tooth because of the thread which forms its teeth has an easy cutting action and leaves a very smooth hole as a result.

The nut *D* for securing the taper plug in place is made by simply running in the drill and facing tool *M* (a combination flat cutter) and following with the tap *N*, which is 7/16 by 16 threads per inch.

This fitting *E* is machined by the tool *O* which drills out the hole in front, sizes the rear for the tap *P*, and faces the outer end. At the same time the inserted 1/4-in. square cutter turns the shoulder to diameter. The tap *P* is then run in to produce a 1 1/8-in. by 14 thread corresponding to the external thread cut with the die on the end of the body of the nozzle *A*.

The die *Q* is for threading the end of the taper plug *B* and cuts a 7/16 by 16 thread corresponding to the thread formed in the nut *D* by the tap *N*.

TURRET LATHE AND OTHER TOOLS

Some tools used in machining brass and bronze work in the turret lathe, engine lathe and shaper are illustrated in the following engravings.

Figure 242 represents a box tool with adjustable boring bar which is used on a phosphor-bronze casting, Fig. 243. This casting has an outside diameter of 2.249 in. and a bore of 1 1/2 in. The smaller bearing of the two in the drawing is 4 in. long, has a diameter of 1.999 in. and a bore of 1 1/4 in.; and there is a minus allowance of one-half thousandth from the bore and external diameters.

These bearings are used on a car lighting system. Both bearings are formed with the oiler opening through the walls, leaving the external and interior surfaces interrupted at the center for about one-half the circumference.

CONSTRUCTION OF THE BOX TOOL

The shank of the cast box tool, Fig. 242, is bored with a taper hole, smallest at the rear end, which fits over a similar portion on

the central bar which extends completely through the box tool and projects at both ends. The taper is of an easy angle of slope and the tool is held firmly in the taper seat by a lock nut at the rear. The arrangement of boring and turning tools in the box holder and bar, is clearly shown.

The boring tool is adjustable for diameter of work, the method of adjustment being by application of the pointed screw *A*, Fig. 242, which bears against the bevelled inner ends of the two boring

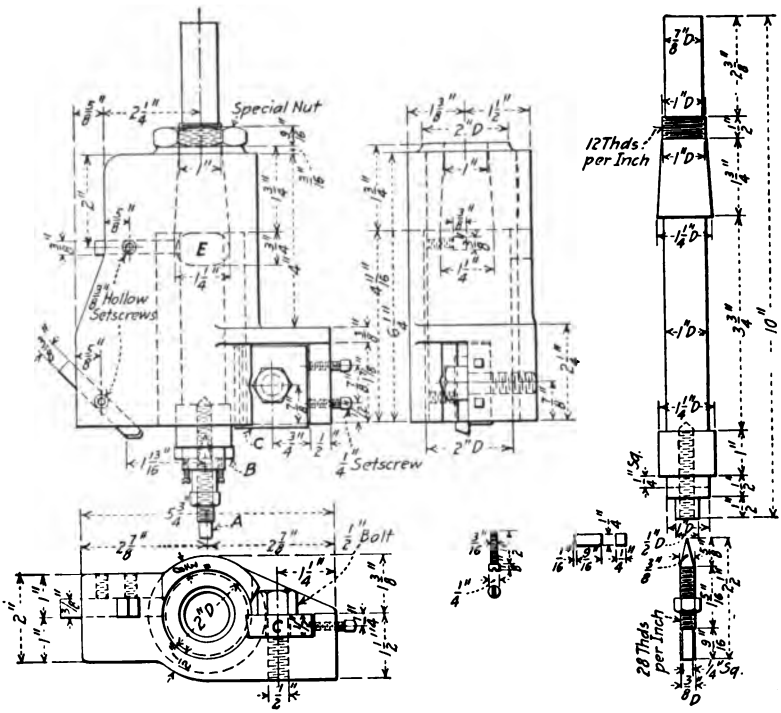


FIG. 242.—Box tool with boring bar.

cutters *B*, these being made of ¼-in. square stock fitted crosswise in the boring bar. Each cutter has a binding screw and the adjusting screw *A*, when properly set, is locked by means of the nut at the front.

The turning cutter *C* is a broad-faced affair 1⅞ in. long, secured in a rectangular seat in the front wing of the box tool body. The turning tool for the flange on the end of the work is a ⅜-in. square cutter inserted at *D* at an angle to give facility of adjustment.

The facing cutter for the extreme end of the work is near the rear end of the chamber in the box tool as indicated at *E*.

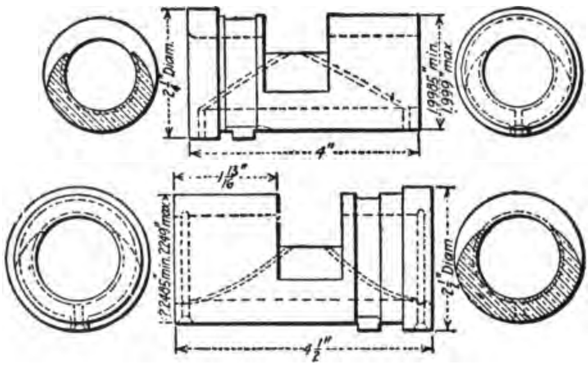


FIG. 243.—Armature shaft bearing.

The tool in Fig. 244 is a form of hollow mill adapted for turning from ¼ up to 1 in. in diameter.

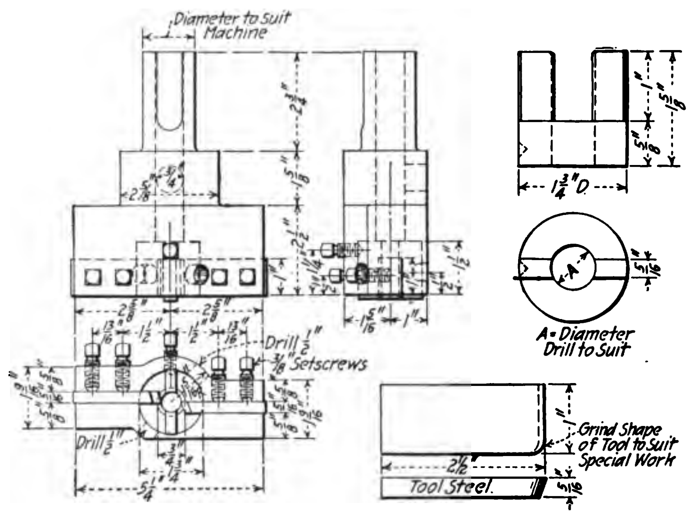


FIG. 244.—Hollow mill.

The bushings with this tool are cut away at opposite sides to clear the cutters, but leaving about one-quarter of the circum-

ference at each side for steadying the work under the action of the tools.

These bushings are made in various diameters of bore, and the set is arranged to cover by sixteenths all sizes between the limits mentioned above. The cutters inserted at the sides are of high-speed steel 5⁄16 in. thick by 1 in. wide. They are each secured by two 3⁄8-in. set screws. It has been demonstrated that this form of tool stands up better on the class of work it is principally used for than the old style of hollow mill, and it is said to have 80 per cent longer life than the earlier type of mill.

The doublebar holder in Fig. 245 is adapted for holding two bars as above, and these are placed 4¼ in. apart on centerlines,

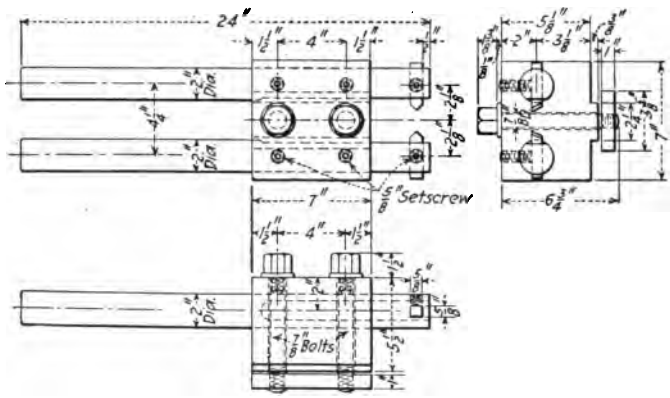


Fig. 245.—Double boring bar.

to carry tools for turning and boring such parts as brass slip rings for eccentrics. This ring has, say, an outside diameter of 18 in., an inside diameter of 16 in. and a width of 3 in. The section through the ring is 1 in. and heavy cuts and feeds are possible with the stiff bars in finishing the outside and inside surfaces. The brass casting for the rings is made in the form of a drum 12 to 15 in. long, so that it may be gripped in the lathe chuck by one end and one ring after another bored, and turned and cut off to width. Both boring-tool holders, the single and the double, are neatly proportioned, giving a bearing length for the bars equal to three and a half times the diameter. The bars are secured by headless screws, as are the boring and turning cutters, so that all surfaces are for the greater part free of projecting screw heads.

A SHAPER TOOL

A tool for various classes of operations on the shaper is shown in Fig. 246. This tool is made primarily for such work as the shaping of brasses for gasoline motors.

The brasses are shaped out with a lip on the upper one and a corresponding seat in the lower one. The tool is adjustable to give any desired offset between the ends of the cutting tools, and in the setting shown the center tool is set about ¼ in. out from the two outer tools. This setting is as the tools would be placed for shaping the work referred to, and with such a job in

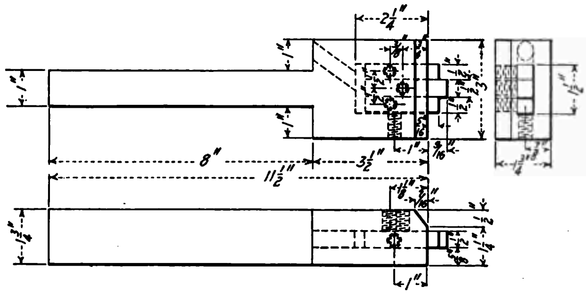


Fig. 246.—Shaper tool.

the shaper the tool could be fed in from one side to surface off the brass, leaving the shoulder or lip of the desired height and thickness, and then moved across to the opposite side and, without readjustment of any part of the machine, fed across that side to bring the face and lip into conformity with the side already completed.

The three tools are held not only by screws tapped into the top of the holder, but also secured from the side by an auxiliary screw at that point. The tools and appliances illustrated in this chapter were made and are in use in the shops of the Southern Pacific Company, Sacramento, Cal.

14

CHAPTER XV

SOME PORTABLE TOOLS AND APPLIANCES

Although a good many portable tools are illustrated in other chapters of this book, it may be well to refer here briefly to certain typical pieces of portable equipment not included under other chapter headings.

Thus the half tone, Fig. 247, serves to illustrate a portable electrically-driven machine for revolving driving wheels during the operation of valve setting. This machine consists of a platform carrying a motor which operates a shaft *A*, extending across the pit and having near each end a corrugated roll *B* to act upon the rear side of the tread on the pair of drivers. At the front of the pair of driving wheels there is another pair of smooth rolls which are carried on studs in suitable bearing blocks.

Two through-bolts *C* parallel with the track, connect each of the front blocks and its smooth roll to the main block for the corrugated rolls *B* behind the drivers. When the nuts on these bolts are tightened up the rolls at opposite sides of the driver rim lift the pair of wheels clear of the track and the motor can then be started to revolve the corrugated rolls slowly and so rotate the driving wheels as required.

ANOTHER OUTFIT FOR ROTATING DRIVERS

Another arrangement for doing away with the barring of drivers on eccentric and valve setting, is an air-driven device. The outfit consists of two small pairs of rolls which are placed in contact with opposite sides of the drivers, as with the first device described above, these rolls being drawn together by means of through-bolts to lift the pair of wheels from the track. One of the rolls is of course corrugated and this is carried on the end of a worm wheel which is driven by a worm connected to the air-motor spindle. The corrugated roll act as a driving medium and the three other rolls are merely supporting idlers. The worm-wheel shaft has roller bearings at each end made up of 3/8 in. rollers operating in a case-hardened bushing.

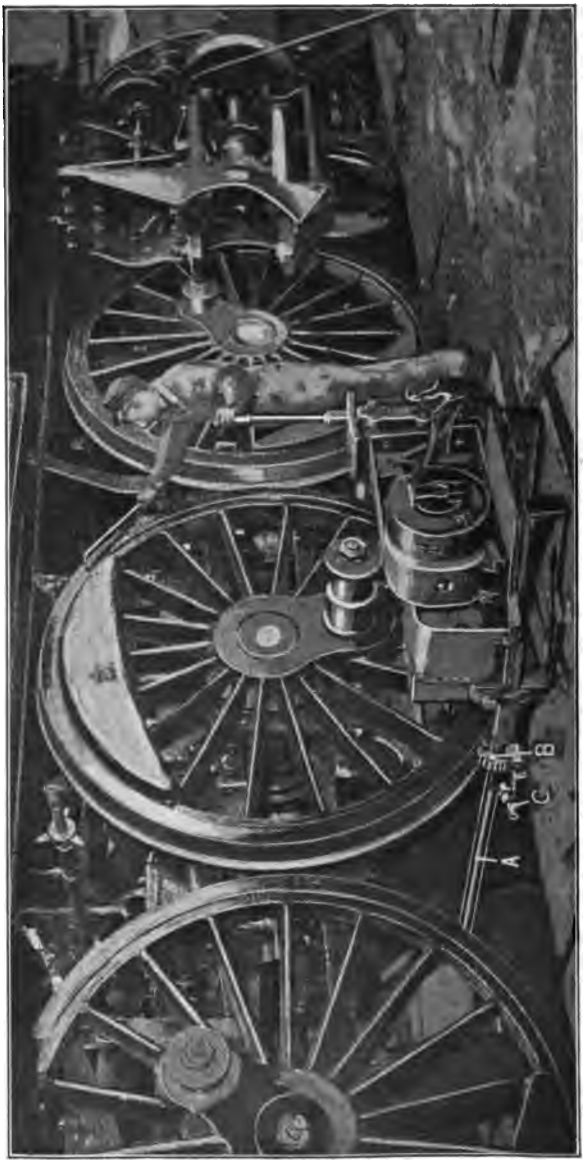


Fig. 247.—Motor driven machine for rotating drivers for valve setting.

An interesting form of engine used at one shop for driving portable boring bars, valve facers, etc., was originally used on a piece of mining apparatus and as converted for use in the railroad shop it was arranged for driving by compressed air. In this instance the engine is mounted upon a metal truck on which it is drawn about the shop and used as a portable driver for cylinder boring and other purposes. The drive from the engine is by means of a round belt or rope from the grooved wheel on the crank shaft.

BOILER WASHING OUTFIT

The boiler wash-wagon shown in Fig. 248 is convenient, because it can be easily hauled around the shop or engine house for

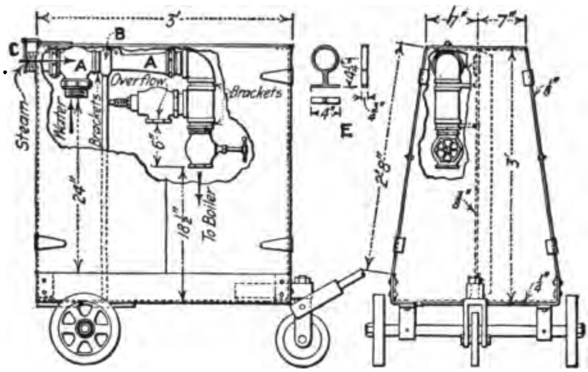


FIG. 248.—A portable boiler washing outfit.

one locomotive or another. The bottom end plates and the top of the box are of ¼-in. boiler iron. The center or partition plate is ⅜ in., flanged and riveted to the end plates, which are flanged at top and bottom and, of course, riveted.

A good thing about this wagon is that there are doors on each side, hinged at the end plates and meeting in the center. They are provided with hasp, staple and lock, so no one can "borrow" the hose. One side is entirely for hose, and both sides are closed and locked when not in use.

The ejector is shown at *A*. The other fittings are ordinary, an overflow being provided as indicated. *B* is a kickoff with a pipe leading toward the floor. Hose is attached to the overflow and leads to the pit on the sewer.

A washer or plate *C* is placed over the steam end, to prevent

dirt from getting into the ejector tubes. The ejector and fittings are held to the center sheet by means of four small brackets *E*. All connections can be easily made, the doors, of course, being open when in use.

A HANDY TRAVELLING DRILL

The outfit in Fig. 249 forms a very convenient piece of equipment for such work as drilling of stay bolts in boilers and for

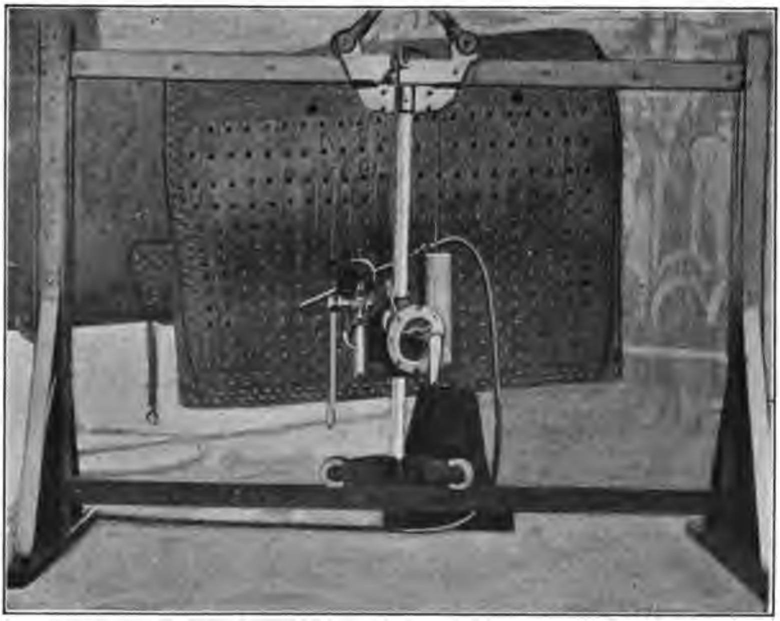


FIG. 249.—Portable driller for stay bolt work.

other operations where a lateral movement of the entire drilling apparatus is desirable. The engraving represents the drill proper mounted on a metal frame which provides upper and lower tracks for it to travel over along a distance of some 8 or 10 ft. The whole affair may be picked up bodily by the crane and moved to any desired point in the shop.

The air drill is mounted at the end of a stiff shaft which is slid in its bearings by rack and pinion to feed the drill to the work and to withdraw it for the next operation. The guide for this drill carrier is adjustably attached to a body which is mounted upon the threaded upright which forms the drill column. Ad-

justment up and down on the column is secured by means of a crank handle. The head is balanced by the counterweight shown.

The drill is adjustable in every direction and is readily clamped at the necessary angle for any hole to be drilled.

FLUE CUTTER FOR FRONT END

Figure 250 illustrates a superheater-flue cutting machine. It is placed on the front end of the locomotive and held with the studs that hold the front end door in place. It is operated by one man and driven with the air motor shown. The cutter is made with an eccentric movement in the cutter holder, so that when applying the cutter to the flue to be cut, the cutter blade is out of the way. As the machine is started, the cutter falls out

FIG. 250.—Flue cutter.

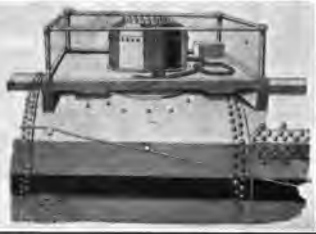


FIG. 251.—Platform.

and pierces the flue, cutting it off with one revolution inside the front flue sheet.

Figure 251 shows a portable platform placed over the steam dome. This is found very convenient in doing work of any kind in the steam dome, removing studs, and taking off and applying dome caps.

PORTABLE CHASING LATHE

An economical feature of some railroad shops is the using over again of piston-head or follower bolts in making repairs. These bolts may be bruised in removing or stretched in service and it is then necessary to true them up and correct the pitch of the thread. Where a portable lathe is available they do not need to be taken to the bolt department and thus delay and extra handling is avoided.

One shop uses a small lathe which may be placed on the bench or anywhere where air pressure is available. The headstock of

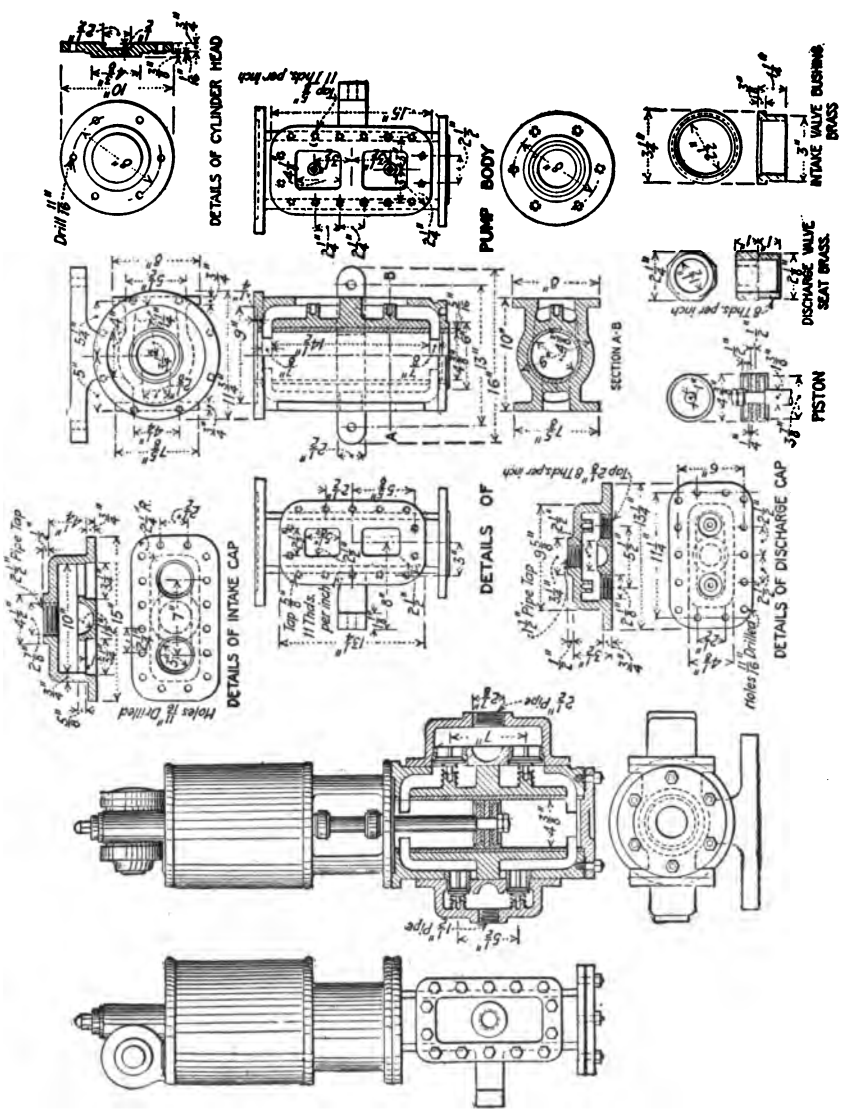


FIG. 252.—Construction and details of boiler test pump.

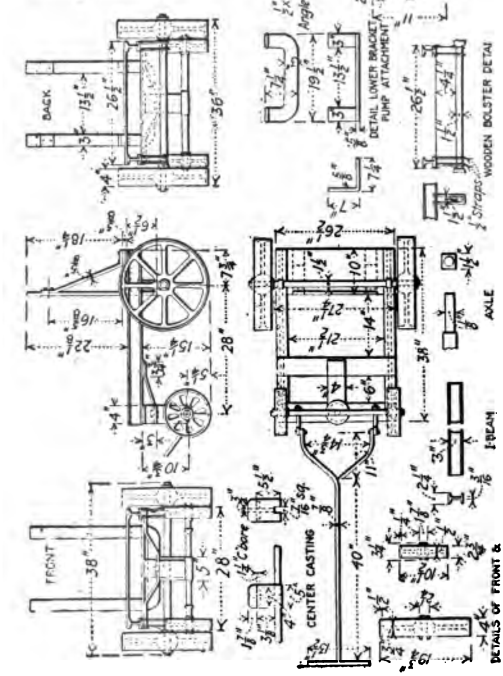


FIG. 252 A.—Truck for boiler test pump.

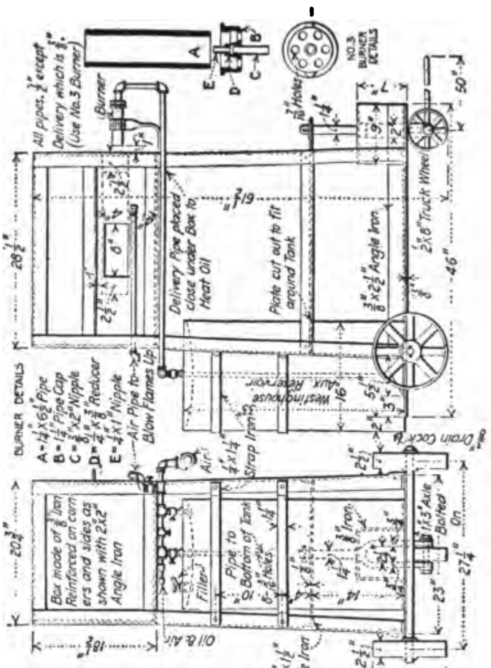


FIG. 253.—Oil rivet forge.

this tool is made up of a small air motor carrying a chuck which receives the square bolt head, and the tailstock is an old miller tail center. The head and tailstock are bolted to an iron plate to form a bed. Behind this is a simple form of chasing device carrying the desired pitch of chaser which requires no leader as it is only necessary to true up the bruised or stretched threads.

PORTABLE BOILER TEST PUMP AND RIVET HEATER

Figures 252 and 252-A illustrate a portable test pump operated by either steam or air, and Fig. 253 shows a portable rivet heater

FIG. 254.—Portable shear.

using crude oil as a fuel in connection with the shop air pressure. These drawings of the boiler test pump and its truck reproduce all essential dimensions. The upper part of the pump is a steam cylinder from a 9½-in. Westinghouse pump. The water end is from a special pattern as indicated.

The portable heater is made to the dimensions given in Fig. 253. The oil tank on this piece of apparatus is filled by backing the truck under a large vertical supply tank secured to the side wall of the shop.

A SHEAR ON A TRUCK

The shear illustrated in Fig. 254 is made portable by mounting it upon a substantial truck with heavy axles and stiff body to allow the machine to be drawn about the shop or yard and used

wherever most convenient for the work to be done. While devised primarily for plate work around the boiler shop, roundhouse and blacksmith shop, it is found to be useful at many other points about the plant.

The portable apparatus described in this chapter is naturally only a small part of the varied class of equipment of a portable character used about railroad shops. As already pointed out many other examples of useful portable appliances will be found under various chapter heads in connection with specific lines of operations.

CHAPTER XVI

SPECIAL TOOLS, CUTTERS, AND TOOLROOM METHODS

The toolroom in the railroad shop is a most important department, handling as it does so many classes of work including special tool operations, the making of cutters for milling and boring, the making and upkeep of punches and dies, tire tools, screw machine and brass tools, and a variety of other work too extensive to classify here except in the most general terms.

One of the interesting lines of special tools turned out in this department consists of the forming tools used for tire finishing operations. Some of these have been illustrated in earlier chapters in this volume. In this chapter the making of such tools will be described along with the handling of a number of other classes of work.

HIGH-SPEED-STEEL TOOLS FOR TURNING TIRES

The practice of the Southern Pacific shops at Sacramento in respect to the making of high-speed formed tools for turning tires is represented by the illustrations herewith.

Fig. 255.—Tire tool, before and after welding.

The solid or one-piece formed tire tool of high-speed steel has of course been long out of the question, leaving as an alternative the built-up tool with a section of high-speed steel secured to the body of carbon steel. At the shops noted the cutting tool proper is forged to approximate outline of the contour required and very little material has therefore to be removed to shape the tool to exact form.

In Fig. 255 a high-speed-steel cutting tool forged closely to

shape is shown in the lower left-hand corner of the group. Directly over this or in the upper left-hand corner is a carbon-steel block which is milled out to form the holder or base for the high-speed tool. The appearance of the holder after it has been cut out for the welding in of the cutting tool is seen at the right, and in the lower right-hand corner is the finished tool ready for service.

Fig. 256.—Right- and left-hand tools ready for finishing.

A group of tools with the high-speed portions welded on is shown in Fig. 256, this illustration showing the tools before any machining cuts have been taken in finishing the working surfaces or cutting-edge proper.

The sketch in Fig. 257 shows the manner in which the holder is cut away in step fashion to provide liberal space at *A* for the

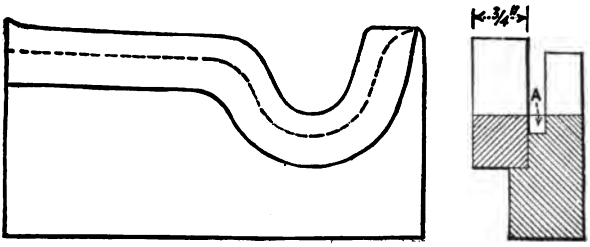


Fig. 257.—High-speed steel tire tool and block.

flowing in of the welding steel under the action of the acetylene torch or the electric arc.

The thickness of the high-speed tool itself is a little over ¾ in. so that it will face down to ¾-in. in grinding. In service it is used down to a thickness of ⅜ in. Thus the life of the tool is extended over a considerable period. The base block or holder

for the tool proper is cut away to the outline of the high-speed section and the front edge of the holder is milled back to provide liberal clearance back of the cutting edge of the tool. These tools are made in lots of a half-dozen or more and the work is facilitated by the use of special cutters in the milling machine.

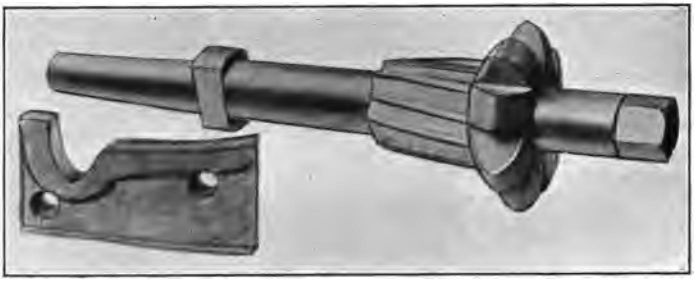


FIG. 258.—Cutters for milling the tool to form.

Figure 258 shows the pair of milling cutters for forming the high-speed cutting edges. The deep cut in the tool for finish-forming the flange on the tire is milled out by the large cutter; the cutter at its side on the arbor is a spiral mill ground to proper shape to form the portion for machining the tread of the tire.

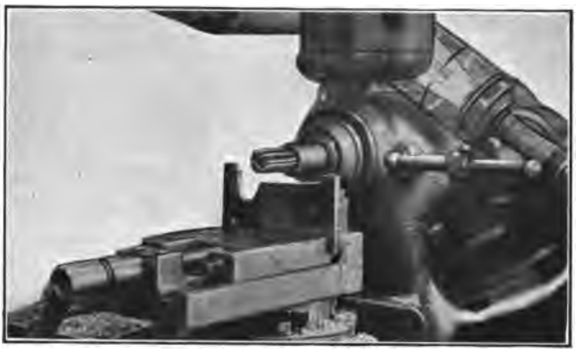


FIG. 259.—Milling out the tool block.

In Fig. 259 the milling machine is shown set up for milling the edge of the tool block to form the clearance under the lower edge of the high-speed-steel section and to provide the seat for the high-speed section itself. The section through the tool and block in Fig. 257 shows the shape of the work at this point.

The method of grinding the top face of the tool in preparing it for service and for resharpening it as it becomes worn in operation is illustrated by Fig. 260. An angle plate is secured to the reciprocating table of the grinding machine and the toolholder is fastened to the upright of the angle plate by two bolts tapped in from the front. The work is then passed to and fro across the face of the cup wheel.

The cutting edge of the tool is finished in the milling process to a front clearance or rake of 7.5 degrees. The top face is ground out with a convex wheel to give a clean lip and provide a free cutting action along the broad face.

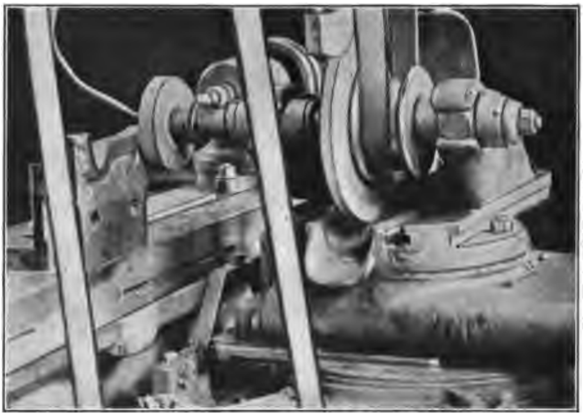


FIG. 260.—Grinding the face of the tool.

MILLING CUTTERS IN THE RAILROAD SHOP

Because of the somewhat restricted uses to which the milling machine as a rule has been applied in various railroad shops there has been on the whole, less advance in the development of milling cutters in such places than is desirable. For the milling machine to be effective it must be equipped with suitable cutters, cutters having coarse-pitch teeth with liberal chip space between, and the cutters must be capable of taking very heavy chips when used on machines of rigid design and ample driving power.

It is a common fault in the railroad shop to find cutters made with teeth of too fine a pitch leaving insufficient space for the chips between them and causing too many teeth to be in contact with the work surface at one time. The teeth will then not have a free cutting action and both cutter and work will become unduly

heated. This condition is likely to be still further aggravated by an unsatisfactory flow of lubricant for cooling and clearing the teeth and work. The cutter is sometimes carried on too light an arbor for smooth operation, the springing of the cutter under these conditions producing a chatter on the work surface which is made more pronounced when the work is improperly supported or because of weakness in the design of the machine itself. The cutter teeth are sometimes milled straight across the face, that is, parallel with the axis, when in many instances and particularly with broad-faced slabbing or surfacing mills far better results would be secured with the helical or spiral form of tooth which because of its shearing form of cut across the work results in a much smoother and easier cutting action.

TEETH OF NEW AND OLD CUTTERS

An important line of work carried on in the tool-room at the Sacramento shops, is the making of various kinds and sizes of milling cutters for use about the machine depart-

FIG. 261.—Coarse and fine pitch cutters.

ments. An interesting comparison of some of their cutter work with some earlier forms of cutters are brought out by Figs. 261, 262 and 263.

Figure 261 shows at a glance the improvement found in the form and number of teeth now used in milling cutters at this shop. There are in the view two ordinary sizes of cutters, one a plain mill 6 in. long by 4½ in. in diameter, the other a side or straddle mill of about the same diameter with a face of 1½ in. The two cutters at the right in this view are of the old design with closely spaced, fine teeth. The three cutters at the left are of the type now made at this place for some years back but only too seldom seen in use even today in the general run of shops.

The old form of side cutter shown was made with 40 teeth for this diameter and the space between teeth is insufficient to permit of satisfactory rates of speed and proper clearance for chips. As such a cutter becomes worn down and is recut for further use the fine tooth pitch becomes even more marked and the life of the cutter for satisfactory service is materially shortened.

FIG. 262.—Group of new cutters with coarse teeth.

With the newer coarse-tooth cutters shown there are only 20 teeth for the same diameter and the advantages of properly proportioned teeth and clearance space are secured. The difference in the teeth between fine and coarse-pitch cutters is brought out even more distinctly upon comparison of the two spiral cutters at the rear of the group in Fig. 261 where the cutter at the right has 22 teeth and the new one at the left 13 teeth only.

FIG. 263.—Coarse and fine tooth helical mills.

The coarse tooth has been used in all classes of cutters made here. Note the examples in Fig. 262 where all types are provided with liberal tooth section and chip space. Also note the four mills in Fig. 263 all 2 in. in diameter, with the two at the right cut with coarse teeth and sharp angle of helix, while the other two

are of old design with teeth so closely spaced as to become ineffectual after they have been ground down to a limited degree.

Actual proportions of teeth are shown in Fig. 264 which illustrates in detail one size of cutter shown already in Fig. 261. This cutter is used on a heavy vertical-spindle milling machine. Its dimensions and the details of the arbor are given in the drawing, Fig. 264. The angle of spiral is 26 degrees or one turn in 30 in. The teeth are cut with a 70-degree milling cutter to a depth of 3/8 in. and are provided with a 7/32-in. fillet at the root.

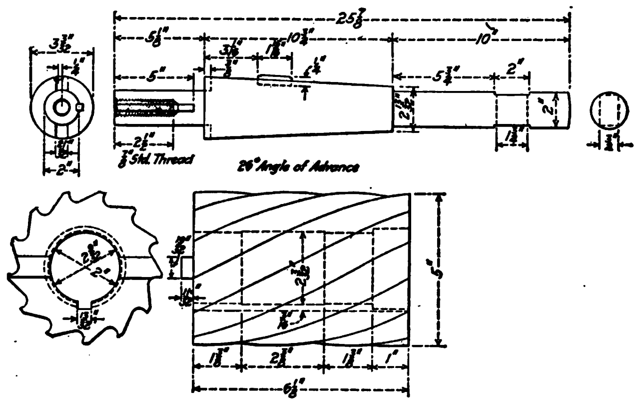


Fig. 264.—Cutter details.

RECUTTING MILLS IN THE TOOLROOM

Cutters of this type after they have been ground down to a point where the teeth need reshaping can be recut, and this process is repeated until the outside diameter has been reduced to 3 3/8 in. and still the teeth are coarse enough to give good results.

Figure 265 shows the method of recutting the mill which is practically the same set up as for milling the cutter teeth originally. The land at the top of the tooth narrows down somewhat as the teeth are recut. This land is of course ground to diameter after the cutter is again hardened. The work is shown set up on the universal milling machine with spiral dividing head for rotating the cutter through the ncessary angle of helix and for indexing for the successive teeth.

The cutting of the keyways in new cutters of this kind is here accomplished on the vertical keyseater by clamping the cutter securely on end to the table of the machine.

15

MAKING A LARGE SLABBING CUTTER

In Chapter VI on "Connecting Rod Operations," reference is made to large inserted tooth slabbing cutters used in this shop in connection with rod operations. One of these cutters is here illustrated in Fig. 266 and details of its features are covered in the line drawing, Fig. 267. The cutters are for use on large horizontal milling machines in slabbing off such work as connecting rods, and are used under heavy cuts and coarse rates of feed. The body of the cutter shown is made of axle steel and the inserted peg teeth are of high-speed steel.

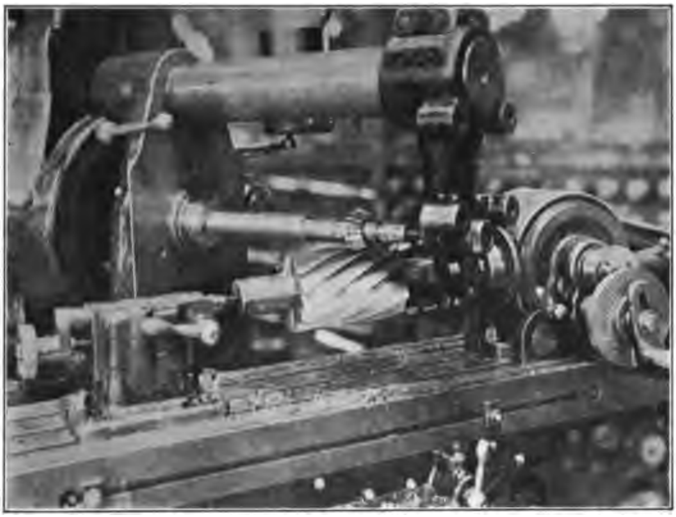


FIG. 265.—Recutting mills.

The cutter illustrated is nearly 2 ft. in length and its diameter is 10½ in. There are 12 rows of teeth, six rows with 15 each and six with 14 teeth. The total number of pegs is 174 As the teeth are set on helical lines having a lead of 115½ in. with a diameter of 10½ in. the lead is equivalent to a helix angle of about 16 degrees. The pegs are offset in each row half way between those of the preceding and following rows so that a staggered arrangement is secured around the cutter body.

The cutter body is 8½ in. in diameter. The teeth or pegs are 1 in. in diameter and 2$\frac{1}{16}$ in. long. They are ground to a top rake of 30 degrees and a side angle of 12 degrees. The holes

for the insertion of the pegs are drilled through the body wall into the bore with a diameter of 3/4 in. and enlarged with a counterbore to a diameter of 1 in. and a depth of 1 1/16 in., so that

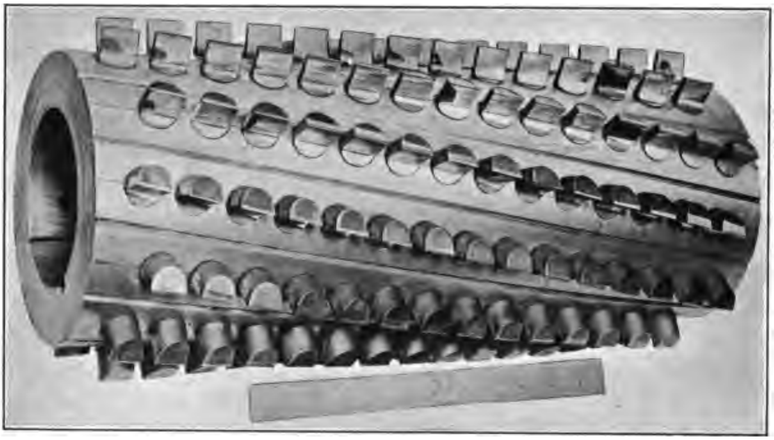


Fig. 266.—High speed inserted tooth slabbing cutter.

the peg projects 1 in. from the body when new. Midway between the rows of holes for the pegs there is a 1/4-in. helical groove which is used as a guide for sharpening the cutter on the grinding machine.

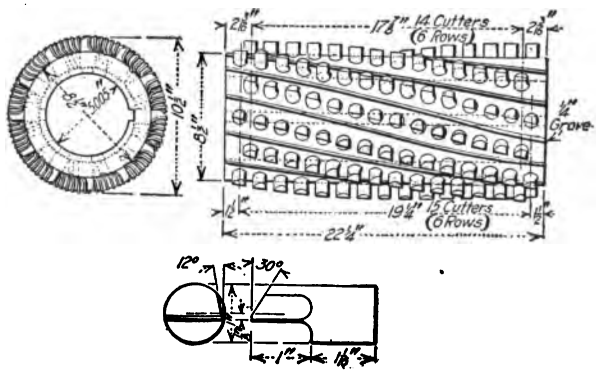


Fig. 267.—Cutter details.

SEQUENCE OF OPERATIONS

The cutter body has a hole clear through to a diameter of 5.005 in. As only one cutter was made at a time no special

tools were developed for the various operations and such machines as were available at the moment were made use of for boring, etc. With this cutter job a horizontal boring machine was utilized for putting through the main hole. The axle-steel body cut off from a length somewhat over size was placed in a heavy V-block on the table of the boring machine and here it was braced by struts and fastened by clamps over the top. First the stock was drilled out and then a boring bar and cutters were used for sizing the hole. Then a 5/8-in. keyway was cut through the bore and the outside was turned to the required diameter the ends being faced square and to length.

The cutter body was placed on an arbor and mounted between the universal dividing head and tailstock on the toolroom milling machine and the helical guide grooves for grinding the teeth were milled in the body. Also layout lines were traced in the same way for the helical positions of the rows of cutter teeth or pegs and with the body still on the arbor circumferential lines about its surface were scribed at the right distance apart for the lateral positions of the cutter peg holes.

The drilling and counterboring of the holes for the cutter pegs was accomplished under the drill press. With the holes laid off for correct centers the cutter body was held in a large table vise and one hole after another drilled, and counterbored to size and depth.

The operation of grinding the teeth of this type of cutter to an even length was accomplished on a Brown and Sharpe grinding machine with the work running at 22 r.p.m. and a surface speed of 65 ft. per minute. The wheel used on the high-speed teeth is a Norton 9 by 1/2-in. alundum 46-J, operated at a peripheral speed of 6,000 ft. per minute. The rate of traverse or feed travel is 48 in. per minute.

REAMERS, COUNTERBORES, AND TAPS

Wherever possible tools such as reamers, counterbores, taps, punch dies and others used in considerable numbers in all railroad shops, should be put through the toolroom in sufficient quantities to enable the work to be conducted on an economical basis. Thus among other jobs in the above toolroom will be seen a large number of taper reamers going through the shop on one order, the bodies being turned squared at the end and prepared for fluting so that the successive operations may be carried along like a manufacturing job.

Similarly one will find there a number of counterbores with interchangeable cutters for boring holes in flue sheets and for general use. These double-end cutter blades are made up in large lots with uniform section of 2 in. wide by ½ in. thick. They are made in sizes from 1½ in. to 6 in., the only difference in the cutters being in their overall length from end to end.

An interesting piece of toolroom equipment at the "Frisco" shops is a tool makers lathe fitted with an opening die head for threading stay-bolt taps. The attachment by which the die head is mounted upon the lathe carriage is a bracket which here takes the place of the tool slide, and which is fed with the carriage to carry the die head over the tap blank in the threading process.

Another toolroom device is a milling attachment which holds three stay-bolt taps for the fluting operation which is accomplished by three form cutters on the arbor. The taps are dogged at the upper end to rotate with the spindles in the fixture head which are revolved in unison for indexing the three blanks for fluting. The centers in the tailstocks are actuated by knurled head screws at the front of the fixture.

PUNCH AND DIE WORK

In making plain punches in some shops the blanks, Fig. 268, are put through in lots of several hundred. These are made

Fig. 268.—Punches for boiler shop work.

on the turret lathe, using one turning cut only. The punch is tapered back from the front end about 1/64 in. in one cut with a carriage tool, the center point formed at the end and

the piece cut off with a cross-slide tool. It is the practice here to make the die itself with $\frac{1}{32}$-in. inside taper or clearance from the top down, and the punch is tapered one-half that amount from the cutting end back, the cutting end thus being $\frac{1}{64}$ in. larger than the rest of the punch body. This is the allowance in taper for 1-in. dies and punches. For $\frac{1}{4}$-in. size the die has an inside taper of $\frac{1}{64}$ in. and the punch a back taper or clearance of one-half that amount. It is common practice to allow for clearance between punch and die of this kind by making the die $\frac{1}{64}$ in. above and the punch $\frac{1}{64}$ in. below nominal size. Complete data on this class of tools will be found in the author's book, "Punches and Dies" and in the "American Machinists' Handbook."

RAPID METHOD OF DIE MAKING

Modern railway-track equipment has undergone many changes in recent years, in order to keep pace with the ponderous locomotives and rolling stock. Tie plates generally adopted and fins or joint plates are being made much heavier and longer, with a vertical flange attached immediately under the joint in order to reduce to a minimum the tendency to sag at this point. To assist in securing increased rigidity, to prevent spring and bending, the railways are also demanding harder material; so hard in many cases that it becomes necessary to shear or punch them hot, and to meet these severe demands, improvements in efficiency and economy in the cost of tools and processes would seem to follow naturally, and the following method of die production described by J. J. Newbaker is about as simple and rapid as could be desired for this class of work.

The dies are turned, drilled, counterbored to within about $\frac{1}{4}$ in. of the face and cut off the bar at one setting in the turret lathe, the drilled holes in the faces of the dies for elliptical or square holes, being made sightly smaller than the shortest diameter of the finished hole.

After leaving the turret lathe, the dies are placed in the holder *A*, shown in the accompanying half tone, a guide the proper size placed on top and a hardened plug forced through. The use of a guide insures the hole being punched in the center of the die. About $\frac{1}{32}$ in. clearance is allowed between punches and dies, or $\frac{1}{64}$ in. all around and so these hardened plugs are made that much larger than the punches to be used in the die.

In the half tone, Fig. 269, *B* is a die just as it comes from the turret lathe; *C* is a finished elliptical die; *D* a finished square die; *E* a square guide; *F* an elliptical guide; *G* a square plug; *H* an elliptical plug; *I* an elliptical die sawed in two to show how it is made; *J* and *K* plungers used to force the plugs through the dies.

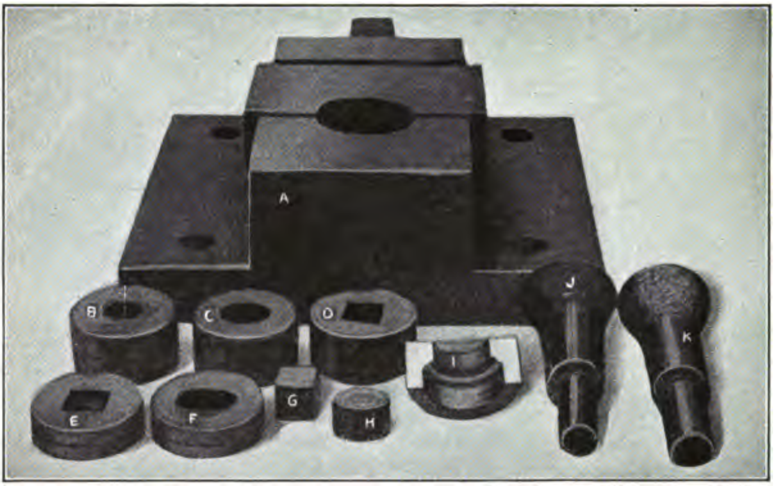


Fig. 269.—Economical method of die making.

A SET OF STRAINER TOOLS

There are many kinds of press tools made in the railroad toolroom in addition to the common punch dies for piercing boiler plate. Thus, Fig. 270 shows a set of tools made in another shop for manufacturing hose strainers which are made up about 5 in. high and with a flange diameter of 3⅛ in. The material is sheet copper 1/32 in. thick. A sheet of metal is cut to a quarter circle as shown at *A*, and then perforated by the punch and die *BC*. The punches are 3/16 in. in diameter and the different rows are sheared slightly, that is they are placed at different heights so that three or four rows pass through the metal before the next series of punches strike the plate, thus making the operation easier on the tools and preventing distortion of the copper plate.

These tools are used in a metal punch and shear. To insure accuracy of alignment between punch and die, the punch and die blocks are sub-pressed by means of two guide pins at the sides. After the perforating operation is performed the section of copper is bent up to conical form and brazed, the tool around

which it is formed being shown at *D*. The open end of the cone is then flared out and flattened by inserting it in the sleeve *E* and applying the flanged punches *F* and *G*, which give the copper shell the desired form at the end.

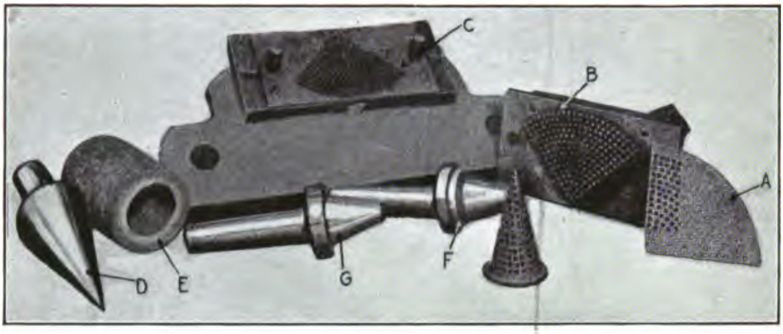


Fig. 270.—Strainer tools.

BLANKING AND FORMING DIES

The railroad shop has ample opportunity for making excellent use of much miscellaneous scrap material for various purposes, particularly where punch press equipment is available. Odds and ends of sheets and miscellaneous scrap may be worked up into various sheet-metal utensils. A characteristic example of tools for such purpose is a set of blanking and forming dies for making dust pans for car and general use. Such tools are of simple construction and will be understood without illustration.

RACKS AND CABINETS FOR TOOL STORAGE

Figure 271 shows a method of storing milling cutters, hobs, gear cutters, etc., on pegs near the toolroom window where they are easily located by the names stenciled in clear characters under the tools. Figure 272 shows a set of shop gages for inside diameters of tires, these being conveniently stored in an "A"-shaped rack over the top of the general tool cabinet.

The revolving type of tool rack is used in some places near the delivery window for drills and taper reamers, while washout plug taps and special taps and reamers are kept in compartments in fixed racks near by. Small taps and drills, tap wrenches and similar tools are placed in racks immediately under the windows. All air hammers used in some shops are returned to the toolroom every night and placed in an oil tank where they are kept in

vertical position. In the morning the watchman opens the cock at the bottom of the receptacle to allow the oil to run back to

FIG. 271.—Storing milling cutters.

FIG. 272.—Gages for tire work.

the supply tank. This system keeps the hammers free from dirt, chips and scale and has been found very effective.

CHAPTER XVII

AIR-PUMP, HOSE COUPLING AND MISCELLANEOUS DEVICES

The special appliances in railroad shops for handling air-pump work, testing valves and gages, refitting hose couplings, etc., are as a rule home-made devices in which are incorporated ingeniously developed features to accomplish the particular class of operations essential to this branch of work. The illustrations in the following pages are reproduced from photographs of a variety of equipment of this character as used in a number of plants.

AIR-PUMP APPARATUS

In many shops the air department forms a most complete section of itself.

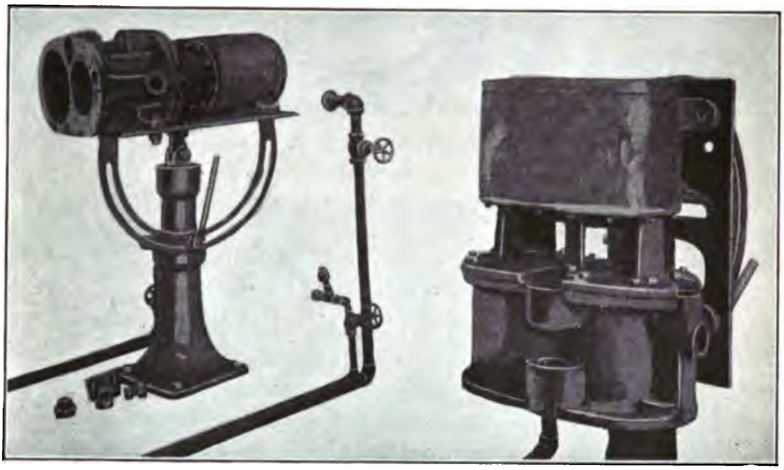


FIG. 273.—Adjustable stands for overhauling air pumps.

The first illustration, Fig. 273, shows a convenient air-pump repair table or stand, which has a swivelling and tilting top for holding the work, so that the pump may be swung to any position in the horizontal plane and tilted up to different angles to suit the convenience of the workman. The table is secured in the desired position by a binder handle on a stud passing through the slotted support upon which the table swings.

POP VALVES AND OTHER WORK

A testing rack is shown in Fig. 274. This is for pop valves. The arrangement of pipes, tank, pump and gages is so clearly represented in the drawing that no explanation is required.

Figure 275 is an interesting view in the Government railroad shops at Balboa, Panama Canal. This shows a most complete equipment of testing apparatus for air pumps, valves, etc. and also includes the racks for pumps and other material.

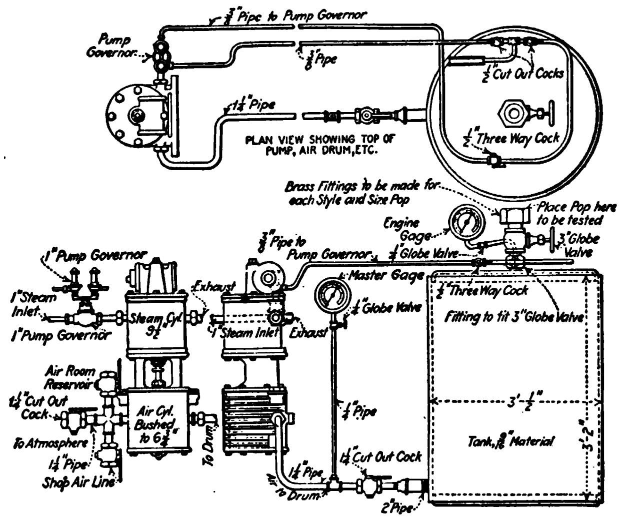


Fig. 274.—Pop valve test rack.

SOME SPECIAL TOOLS

The line drawings, Figs. 276, 277, and 278, give complete details of some valuable tools for use in connection with air equipment. The first of these blue prints shows 2¾ and 3-in. expanding hand reamers (self-feed) for reclaiming worn Westinghouse air-pump governor cylinders. Figure 277 is an expanding reamer (self-feed) for feed valve on automatic-brake valve for train-line pressure. Figure 278 shows details of a 4-in. reamer for reclaiming worn distributing valve bushings for air-brake equipment. In all of these drawings the reamer parts are shown assembled and in detail so that their construction is clearly brought out.

AIR-HOSE OPERATIONS

The operations of splitting old air hose from connections and mounting new connections and their clamps, is another branch of

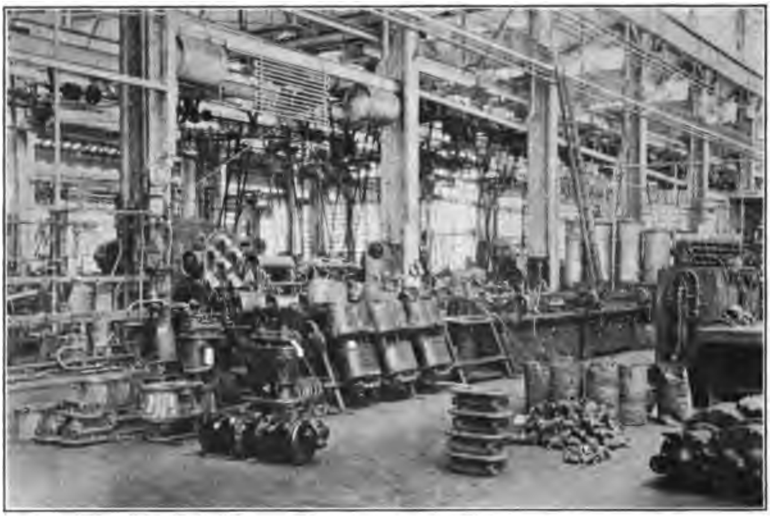


FIG. 275.—Air and other testing apparatus at U. S. Govt. Shops, Balboa, Panama Canal.

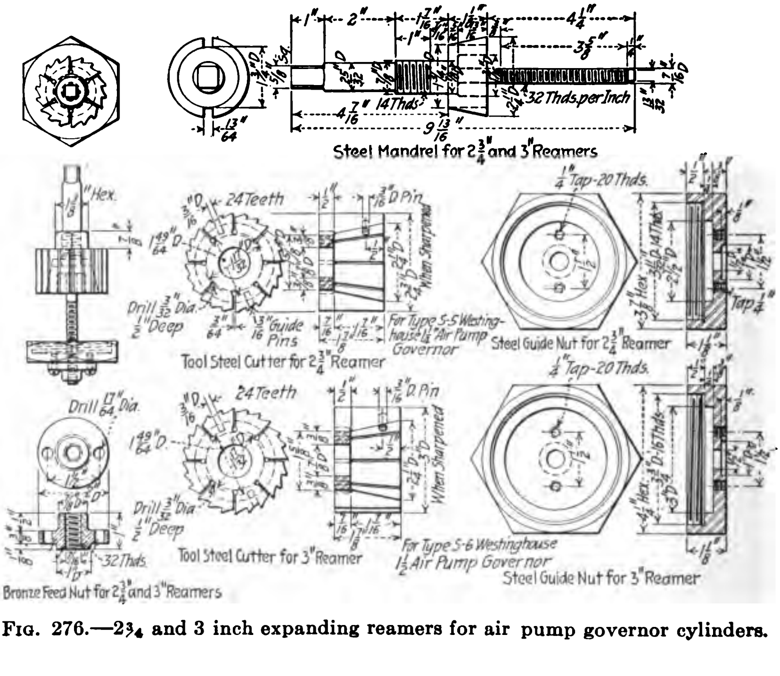


FIG. 276.—$2\frac{3}{4}$ and 3 inch expanding reamers for air pump governor cylinders.

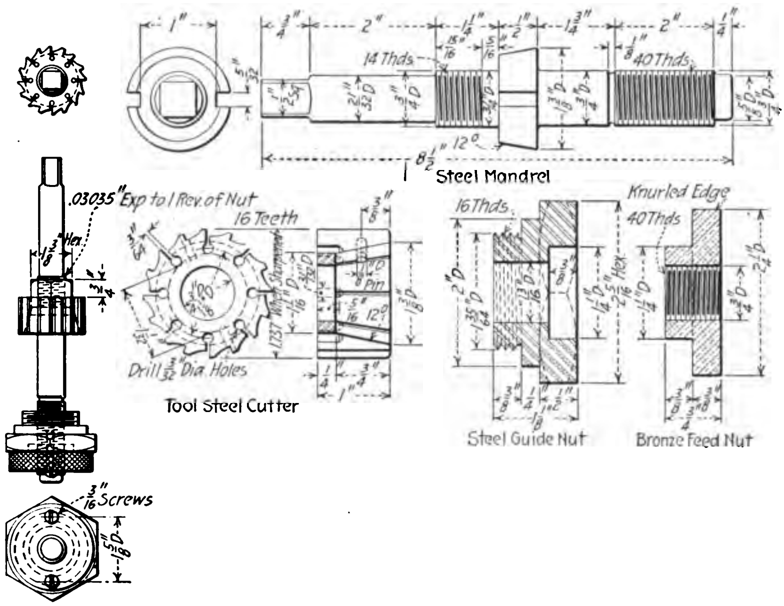


Fig. 277.—Expanding reamer for feed valve.

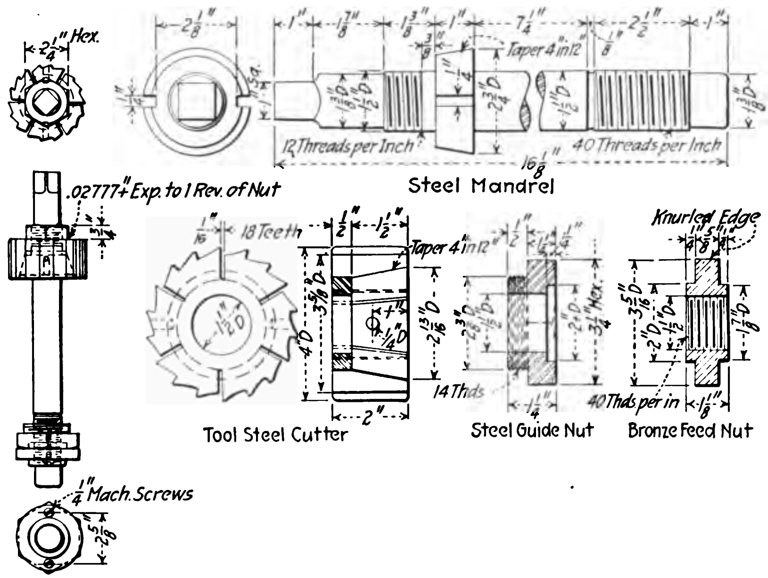


Fig. 278.—4 inch expanding reamer for valve bushings.

work in which some interesting apparatus is employed. In the main such equipment is developed in the home shop and as a rule it is operated pneumatically.

The apparatus commonly used in shops for removing nipples and couplings from air hose consists of a pneumatic device with vertical air cylinder, piston and rod carrying a pair of splitting knives. The hose is placed in a V-block under the ram and a turn of the air valve causes the piston to descend, forcing the splitting knives through the walls of the hose and tearing it from the connection.

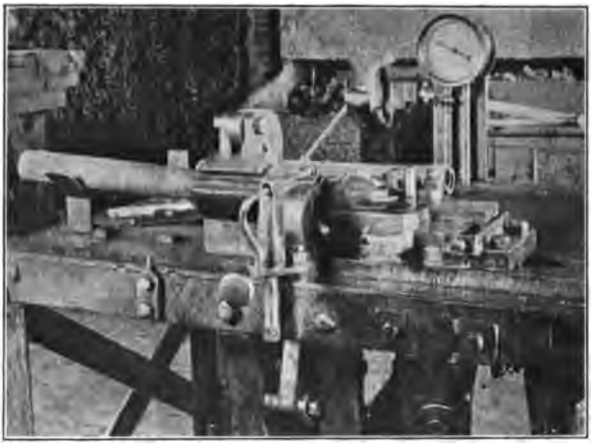


Fig. 279.—Air brake hose-mounting machine.

A machine for mounting hose connections is shown in Fig. 478. The fittings are first dipped in a preparation of black varnish mixed with distillate in the proportions of one to two to thin the substance to the desired consistency. After drying, they are remounted in new hose with the aid of the apparatus, Fig. 279. This is a pneumatic machine with air pistons for controlling the action of the jaws and the movement of the carrier for the coupling.

The length of hose with the clamp on one end is slipped into the horizontal fixture on the bench and the coupling placed on the slide at the right. The top jaw is shown elevated, but the instant that air is admitted to the bottom operating cylinder, the jaw grips the hose fast while the air-operated slide at the right is forced forward pressing the coupling into the hose. This

movement takes place rapidly and is followed instantly by the closing of the narrow jaws near the end of the hose upon the clamp which is then tightened in place by application of the crank wrench at the front to the nut on the binder bolt in the clamp. The wrench is carried in a swivel holder and is easily applied to the clamp nut.

Another type of machine for applying clamps to hose lengths is shown to the left in Fig. 280. At the right in the same photograph is shown the apparatus for testing the hose under pressure.

FIG. 280.—Applying clamps and testing hose.

MISCELLANEOUS TOOLS AND APPLIANCES

The remainder of the illustrations and descriptive matter in this chapter covers a variety of equipment details in the way of special tools and devices for locomotive and car work.

A handy attachment applied to drillers of various sizes for holding the work without loss of time in fastening and releasing the piece consists of an air cylinder under the drill table which has a 6-in. bore and the stroke is 8 in. The piston rod extends up through the center of the table and is forked at its upper end to carry a long clamp bar which is pivoted at the center. The piston and clamp are lifted to release the work by a heavy spring between the underside of the piston and the bottom of the cylinder. The work is clamped by air pressure upon the upper side of the piston.

A convenient bench head is used in some shops for grinding all sizes of joint rings. This carries a series of adapters or split chucking rings, which fit the interior of the different sizes of joint rings. Abrasive material is fed to the revolving ring, and the outer member of the joint is held against the ring by hand until a close joint is ground.

A GRINDING RIG

Another bench machine is used for grinding in gage cocks and valves of various kinds. It consists of a plain spindle with a chuck at the front end and a connection at the rear by which it is attached to an air motor. The speed of the spindle is easily controlled to suit the size and nature of the valve which is being seated. The spindle of the work is gripped in the chuck jaws and the body of the valve held in the hands of the workman who applies emery and oil to the work and puts on the necessary pressure to accomplish the operation.

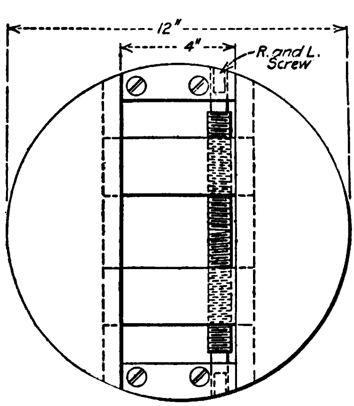


FIG. 281.—Chuck with floating jaws for rough bolts.

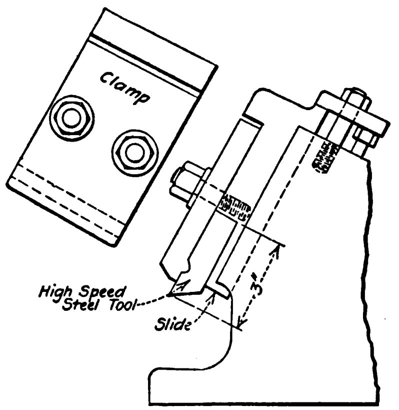


FIG. 282.—Method of holding forming tool in a block.

LATHE CHUCK WITH FLOATING JAWS

A chuck is illustrated in Fig. 281 for driving such work as square-head bolts or other bolts, which are placed on centers and loosely held between the chuck jaws. The latter are closed by a right- and left-hand screw and have a floating movement of about one-half inch to-and-fro in the slot across the chuck face, the screw having that amount of end play between its bearings at opposite sides of the chuck.

FORMING TOOL AND HOLDER

The flat forming tools used in the turret-lathe tool block, Fig. 282, are made quite short and the former method of providing them with a dovetail to fit the holder has been superseded in this instance by an arrangement consisting of a dovetailed slide, in which the tool is secured by a substantial clamp. Thus considerable saving is made in high priced steel and the making of the tool becomes a simpler matter.

The lower end of the clamp is formed with a bevelled rib extending the full width of the underside, and this takes a bearing against a sloping groove across the face of the forming tool so that the tool is drawn back against its abutment when the clamp is tightened.

A TAP FOR CASTELLATED NUTS

A tap for castle nuts is made with the back of the tap unfluted so that when the tap is run through from the back of the nut, the rear portion forms a guide which prevents the tap from jumping and catching in the castellations as it passes out at the front of the nut.

BORING FIXTURE FOR LINK HANGERS

A fixture for boring link hangers on a horizontal-boring machine is shown by Fig. 283. The same apparatus could be

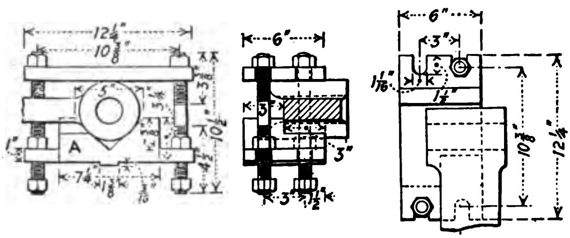


Fig. 283.—Fixture for boring link hangers.

used on the vertical mill or in any other way desired. The boss on the end of the link hanger is centered by the V-block shown at *A*, the other views giving all necessary information as to its use.

JIG FOR DRILLING SOCKETS

The drilling of sockets or sleeves for the key used in driving out taper shanks is accomplished by the jig shown in Fig. 284.

16

The top and bottom pieces are made of the same size and are bolted together with four cap-screws as shown. A tin liner is inserted between the pieces while the two holes lengthwise of the jigs are being finished. The top piece can then be cut into two parts, as shown. The removal of the tin liner allows the socket to be firmly clamped when the two parts of the jig are drawn together.

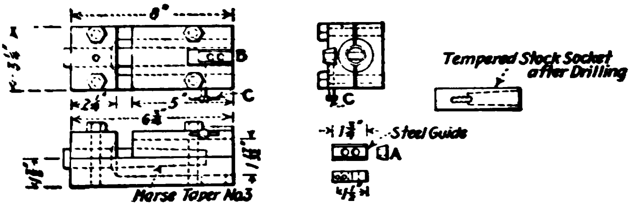


FIG. 284.—Jig for drilling drill sleeves.

The drill is guided by the steel block shown at *A*, this being fastened in the proper position in the dovetailed slot as at *B*, and held by the cross-handle screw *C*. The jig shown is made for a No. 3 Morse taper socket with the outside turned to a No. 5 taper. Modifications of this can readily be made to suit other conditions.

COTTER KEY FOR RAILROAD SERVICE

The cotter keys used in railway service are often punched out as shown in Fig. 285. The two halves are placed together and

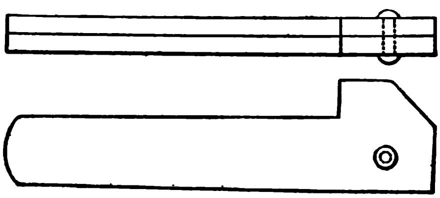


FIG. 285.—Old method.

a rivet is put through their heads. This means at least three different operations.

At the Shoreham shops of the "Soo Line," they take old boiler tubes, flatten them out and punch all the cotter keys from about 2½ up to 4½ in. length out of them. Such a cotter is shown in Fig. 286. No riveting is required, and as old flues are to be had in abundance in any railroad shop, the material costs prac-

tically nothing. Most tubes or flues can be flattened cold under the steam hammer, although some of them crack at the fold. Heating and running them through a small roller is a better method.

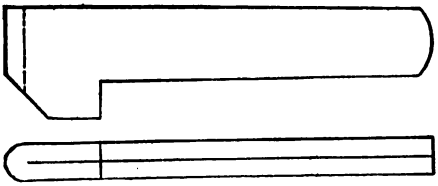


FIG. 286.—New method cotter key.

A SPREADING TOOL FOR MAIN ROD STRAPS

Figure 287 shows a tool for spreading main rod straps, coupler yokes and the like. It is shown in position between the two

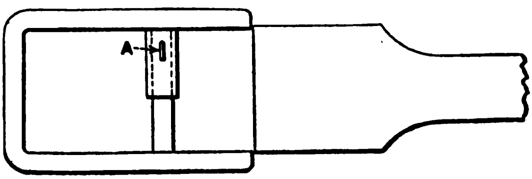


FIG. 287.—Spreading tool.

prongs of a main rod strap. The taper key *A* is driven in until the prongs will easily pass onto the main rod. The taper key is then backed out and the device removed.

CHAPTER XVIII

BLACKSMITH SHOP, EQUIPMENT AND WORK

It is seldom one has the privilege of visiting a better organized or more neatly conducted forge shop than that in the plant at Sparks, Nev. The clean, exhilarating atmosphere and the clear sunlight peculiar to this section of the West are naturally important factors in the satisfactory operation of an industrial plant. These features have gone far toward making possible at Sparks the maintenance of a blacksmith department along lines that might well be followed in many larger establishments doing a manufacturing business.

The variety of work handled in their shop and the methods of accomplishing results in forging, forming, welding, etc., are of considerable interest.

Both oil and coal fires are used in the shop, and in connection with the oil-fired forges and furnaces, several of which are located along the shop wall, some noteworthy cooling apparatus has been developed and installed. The operation of this equipment has thereby been made most effective and satisfactory by reducing to a negligible quantity the volume of heat that would otherwise issue from the mouth of the forge to the discomfort and disadvantage of the workman.

Figure 288 illustrates clearly this cooling system as applied to an oil-fired heating forge or furnace. The piping for oil fuel and for the air supply, with the controlling valves, is shown at the left side of the casing. The cooling apparatus for preventing the discharge of hot gases directly outward from the furnace mouth consists of two elements: One, a series of minute steam jets discharging vertically from a point directly in front of the flame to carry the gases upward; the other, a baffle-plate in front of the vertical heat zone thus formed. This plate is made to serve as a most effective cooling shield through the medium of a row of water jets that, flowing downward from the top of the baffle-plate, provide a continuous film over the entire outer face of the sheet metal.

The pipe from which the small steam jets play upward is shown in horizontal position immediately in front of the mouth of the furnace. The water pipe passes upward at the front; and the horizontal length extending across to the right, which is drilled with small holes to allow the water jets to discharge downward, also serves as a support for the upper end of the sheet-steel baffle-plate. The lower edge of this plate rests in a V-shaped channel that slopes slightly to the left and discharges the water into the funnel-shaped mouth of the vertical waste pipe.

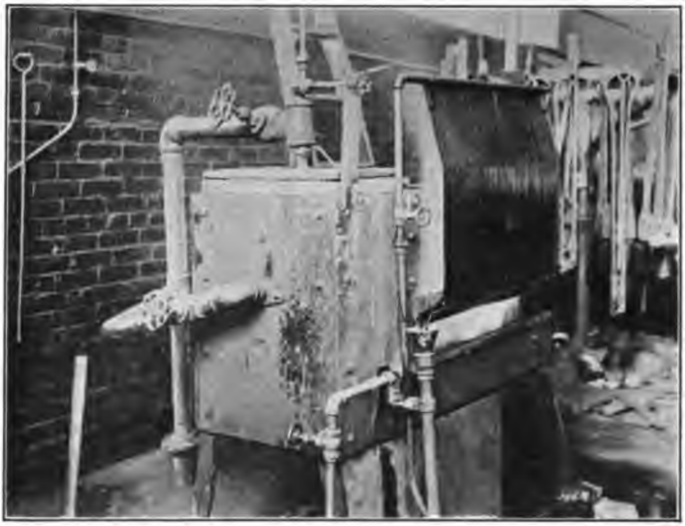


Fig. 288.—Oil furnace with apparatus for cooling.

The camera has registered accurately the visual effect produced by the combined action of the upshooting steam jets and the confining baffle-plate. The actual results so far as concerns the practical elimination of heat at the front of the apparatus can be appreciated only by personal observation and test. It is of interest to be able to state in this connection that the bare hand may be held on the face of the metal plate for an indefinite period without other sensation than that of a mild degree of warmth.

The forge, in Fig. 289, is an open brick-chambered blacksmith fire operated by oil fuel and provided with a steam-jet system for diverting the flame upward, thus securing the same advantages

as described in connection with the apparatus illustrated in Fig. 288. The application of the water-cooled baffle-plate is impracticable in this case, and in any event is not required owing to the location of the heating chamber in respect to the working edge of the forge.

The steam pipe lies across the forge just in front of the mouth of the fuel chamber, and the action of the series of fine jets in carrying the flame and gases directly upward is illustrated with remarkable clearness in the illustration, Fig. 289.

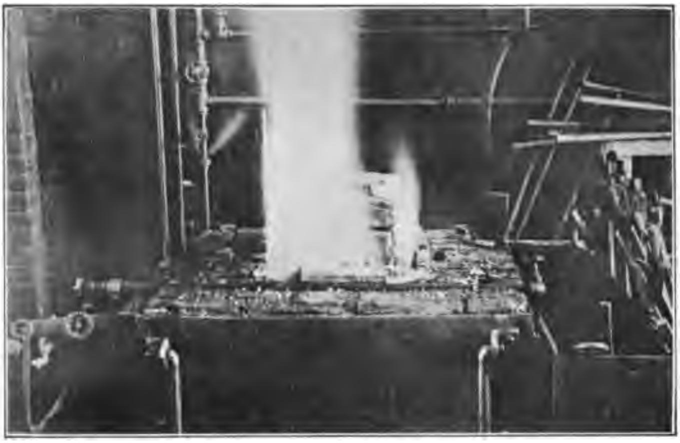


Fig. 289.—Forge supplied with cooling steam jet.

CARE OF TOOLS

Taking proper care of miscellaneous tools about a blacksmith shop is an undertaking with difficulties of its own, and only too frequently little attempt is made to solve the problem at all. Tongs, chisels, swages, dies and the like are apt to be thrown in a heap when out of use; like all tools improperly stored, they are difficult to locate when wanted, and when found are in anything but first-class condition. In contrast to this fairly common state of affairs, it is a pleasure to illustrate the systematic manner in which such tools are taken care of in the shop forming the subject of this article. Two views, Figs. 290 and 291, represent two types of racks that permit blacksmith tools of all kinds to be kept in good order, so as to be easily located when needed and readily removed for use and replaced when their work is com-

pleted. The first of these racks is for heavy tools and is located behind the big power hammer, as indicated. It is circular in form, consisting of a steel ring some 6 ft. in diameter supported

FIG. 290.—Circular rack for heavy blacksmith's tools.

upon a series of arms branched out from the standard, which is mounted in a square flange at the base. The supporting hooks for the tools are U-shaped and double ended. When

FIG. 291.—Racks for tongs and light tools.

placed over the ring that forms the top of the rack, one end projects in and the other out, thus enabling tools to be hung up inside the ring as well as outside.

The rack in Fig. 291 is also of metal and is for three banks of tools, which are separated sufficiently from one bank to the next to allow any given tool to be selected easily. In form, the rack is a rectangular frame supported at the rear by standards that slope backward toward the wall and carry two additional horizontal bars for holding tongs and similar appliances.

BENDING AND FORMING

A special device for various bending and forming operations is the home-made machine shown by Fig. 292. It is used for light and medium work. The ram is operated by an air piston, the

FIG. 292.—Forming and bending outfit.

controlling valve for which is located at the front of the cylinder. The end of the ram is fitted with a slotted head that carries a former of the required shape to suit the work in hand, and the opposing die or anvil is of course made to conform to the bend or angle desired. The cylinder is part of an old air-brake equipment and has a stroke long enough to answer for a wide variety of parts requiring forming up in this manner.

SAMPLE BOARDS FOR FORGINGS

We are accustomed to seeing in certain manufacturing plants sample boards carrying parts which are made in quantities, these

aiding in many cases in getting tools and gages made properly and leading to a complete understanding as to just what a particular piece is like. They may be used in conjunction with drawings or by themselves as a check on the accuracy of duplicate parts produced in their likeness, as they can be considered models or master parts by which manufactured pieces can be checked. It is not often, however; that the sample board is used to any great extent on such heavy work as locomotive and car forgings. As a matter of fact there is no more useful place for such sample boards than the railroad blacksmith shop.

FIG. 293.—Sample boards for engine and car forgings.

In Fig. 293 some racks carrying large sample boards with forged parts are shown as used at the forge shop of the Southern Pacific general shops in Sacramento. These are fitted up with forgings of all kinds, large and small, and prove a great aid in the handling of various classes of material. As a rule a drawing or sketch for a blacksmith does not carry an extra number of dimensions, and if the regular machine shop blue print is used there are apt to be so many figures thereon of no importance to the blacksmith that they lead to more or less confusion. Consequently a real sample of the part is often an aid in keeping before the smith just what the part is to be like as it leaves the anvil. It enables him, if he so desires, to measure or caliper any part of the piece for duplication of a dimension, and such samples further form checks on the accuracy of general forgings as well as for numerous parts formed up in dies on the bulldozer or otherwise.

FORGING AND FORMING OPERATIONS

The shops just referred to do a great deal of forging and forming work and many bulldozer and other tools are used for bending and forming engine and car parts. Some of this work is illustrated in the following engravings.

Fig. 294.—Dies for forming draft-sill reinforcing plates.

Fig. 295.—Forming work in the bull dozer.

A set of dies for forming draft-sill reinforcing plates is shown in Fig. 294. These dies are used in the bulldozer and a lot of reinforcing plates formed by them are shown in the background.

A bulldozer in operation on another part is shown in Fig. 295 with the formed plate just coming out of the dies.

OTHER BULLDOZER WORK

The dies in Fig. 296 are for manufacturing push-pole corner irons for box cars. The iron part as formed is shown resting on

FIG. 296.—Bulldozer dies for push pole corner frames.

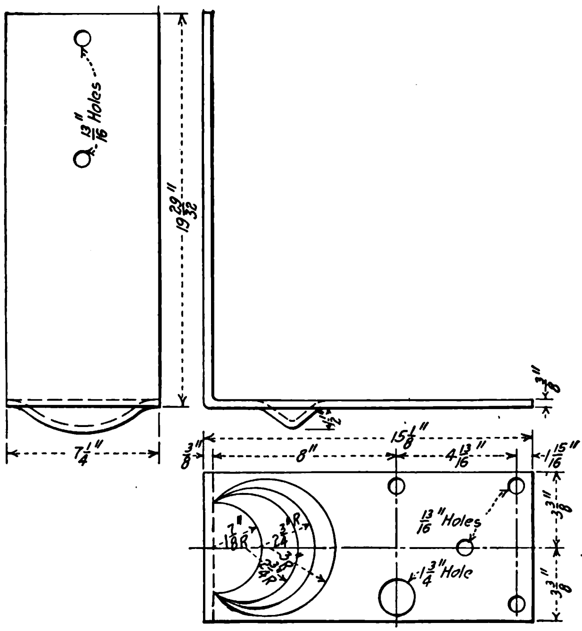


FIG. 297.—Corner iron.

one of the dies and in Fig. 297 details are given in full. The metal is ⅜ in. thick. The pocket is drawn down to a depth of 1½ in. The shape of the pocket is well brought out by the

sketch, Fig. 491. One leg of the iron is $19\frac{29}{32}$ in. long, the other $15\frac{1}{8}$ in.

The dies are of course of cast iron. The metal sheared for the push-pole pocket, is placed hot in the dies and one stroke of the bulldozer does the work of forming up the pocket and at the same time the right-angle corner is bent as shown. By means

FIG. 298.—Bull dozer dies for drawbar carry irons.

of the lever the job is clamped fast at the corner of the dies for the forming operation.

The dies in Fig. 298 are for drawbar carry irons, details of which will be seen in Fig. 299. One of the carry irons will be noticed on front of the punch die at the right, in Fig. 298. The work is performed at one heat. The blank metal is secured

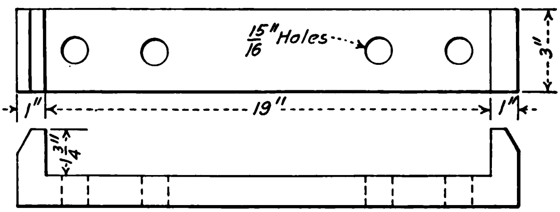


FIG. 299.

against the die by means of the clamp and long lever which force the work into place and bind it against the die face through the action of cam-shaped hooks on the under side of the forked lever, these hooks engaging with the rear surface of the ledge on the die face.

FORMING AND FORGING TOOLS

The bending tools in Fig. 300 are used for forming up hinges for floor racks on refrigerator cars. This bending outfit is used in connection with a pneumatic machine, the piston of which actuates the toggles for closing the jaws and bending the hot piece of metal around the forming posts and forming the right angle corners for the feet around the ends of the jaws. Various jaws are

used here for different classes of work, all of which are bent to form at one stroke of the air piston.

FIG. 300.—Forming tools in floor-rack hinges.

The forging-machine dies in Fig. 301 are for forming up the ends of brake hangers. The rod on top of the dies is thus formed

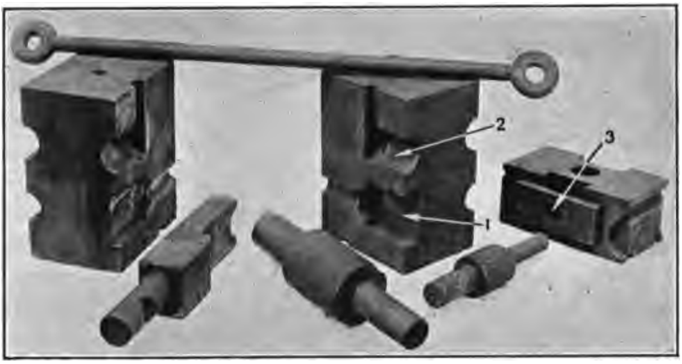


FIG. 301.—Dies for forming ends of brake hangers.

on the ends, after which the hanger is bent up to loop shape as in Fig. 302 which shows several types of hangers. The main

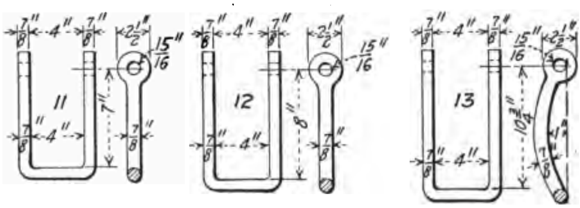


FIG. 302.—Brake hangers.

dies in the photograph upset and swage up the round end on the hot metal in two operations then the hole is pierced with the punch and die at the right.

In connection with machine forging, J. C. Breckenridge shows the evolution of a beading tool as made in the "Frisco" shops, as follows, referring to Fig. 303. First, flattening; second, punching; third, forming; fourth, grinding off fins, and rounding off edges with file; fifth, hardening and tempering. As it is made from $\frac{7}{8}$-in. octagon steel the upsetting of the steel with its resulting evils is avoided.

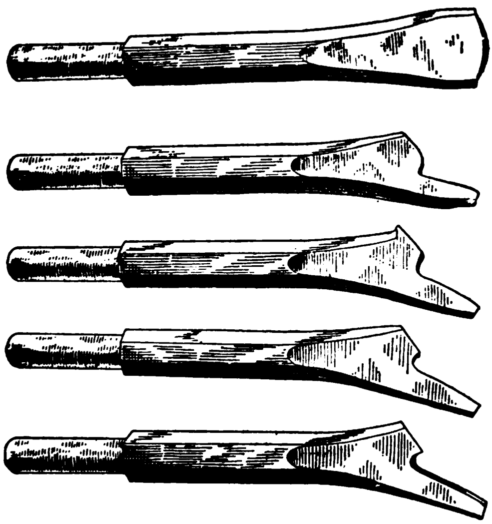


FIG. 303.—Machine forged beading tools.

The hardening of the tools is accomplished with an oil-burning tool furnace and a pyrometer to register the proper hardening temperature. In drawing the temper, an oil-tempering bath with an indicating thermometer is used. The tools are handled in lots of 500. The average amount of service from a beading tool is 4,000 flues beaded before it has to be re-formed. The forging-machine dies are made from machine steel with Vanadium alloy tool-steel inserts.

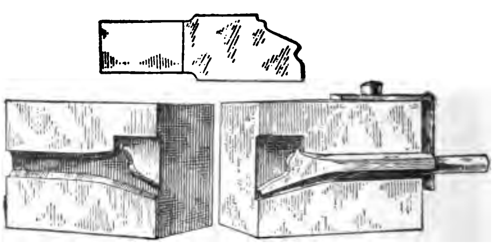


FIG. 304.—Dies for beading tools.

The success of this tool is chiefly due to the methods employed in its manufacture. It is made from annealed low-carbon tool steel. The blanks are first cut to length from the stock bars in a power shear, four blanks being cut off at each stroke. The round shank end, $1\frac{1}{16}$ in. in diameter, $2\frac{1}{2}$ in. in length, is next turned in a lathe with the aid of box tools. The blanks are taken to the forge shop and heated in an oil-burning furnace and formed in a 2-in. Ajax forging machine.

BOLT AND NUT FORGING DIES

A set of dies for the manufacture of piston-rod castellated nuts as used by the Chicago & Northwestern Ry. is shown by Fig. 305. These dies are described by B. Hendrickson as follows:

On all its new and heavy power the Chicago & Northwestern Ry. has done away with the key type of crosshead and is using the design in which the piston rod is held in place by a large castellated nut. As these nuts have worn out in service the mechanical department has been confronted with the problem of replacing them. The dies shown in the accompanying illustration have been instrumental in solving the problem.

The illustration, Fig. 305, shows the dies with the various headers used for making both blank and castellated nuts. The dies in this case are made to fit a 6-in. Ajax forging machine. As

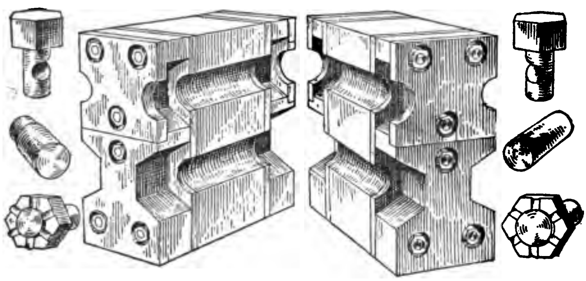


Fig. 305.—Dies for piston-rod nuts.

is readily seen, they are sectional; each half-die consists of seven distinct pieces, and also each die may be said to be two-faced. They may be turned end for end in the machine, or the two outside faces may be made the two inside faces. This design is to accommodate a variety of sizes of nuts, which will be named later. The main body of the die as shown is made of cast iron. All the remaining pieces should be made of either soft steel or tool steel. If made of tool steel, the various laminations should be tempered; if soft steel is used, they should be case hardened. The four end plates shown bolted to the ends, serve to protect the cast-iron sections. As they wear away, they may easily be replaced or built up by the oxy-acetylene process. As may be noticed, some

Size of Nut, Inches	Across Flats, Inches	Style	Width of Nut, Inches
4¼	6⅛	Hex—castle	3
3½	5½	Hex—castle	2½
4¼	6½	Hex—plain	3
3½	5½	Hex—plain	2½
3½	5⅜	Hex—plain	3

parts are recessed out to carry plates. The object of this design is to facilitate replacement of these pieces in case of accident. The laminations are bolted to the body of the die by 1-in. studs.

A separate plunger to fit the crosshead of the machine is not made for each size of nut. One main body only is made, and the various plunger heads shown are fastened to this main body by set screws.

The sides show the results of the two operations necessary to form a complete nut. The pieces are formed in the bottom recess of the dies. The bar stock is upset, and by the use of the proper plunger either a plain or a castellated nut is formed. The completed nut is shown below. It is formed in the top recess of the dies by punching out the center of the piece. One heat only is necessary.

The accompanying table shows the different nuts made in these dies.

BOLT RACKS

A handy type of rack used at the Sacramento shops for bolt work is illustrated by the half tone, Fig. 306. This rack is made up of two steel bars bent edgewise to a U-shaped frame with tie rods for fastening the frame members at the right distance apart. The arrangement makes a very neat and stiff form of rack and one that is easily constructed to any desired dimensions according to local requirements.

SPRING OPERATIONS

Two machines are used in the Missouri, Kansas & Texas shops at Parsons, Kan., for banding springs and for removing the bands from old springs.

The band to be removed from an old spring is heated and then the spring is placed in the horizontal forming press, with one end resting against an adjustable abutment and the other end between the jaws extending from the ram. The ends of these jaws project far enough to pass along the sides of the spring and act

against the hot band, which is thus pressed off without difficulty and without injuring the band itself.

In putting bands onto springs in a pneumatic machine, the built-up set of leaves is gripped in the vise by the action of one of the horizontal air pistons, then the hot band which has been slipped freely over the bent members of the spring, is worked down and fitted tight to the spring by the kneading pressure applied from the top by a long lever actuated by the vertical piston and from the sides by the horizontal pistons. The flat dies or shoes thus forced against the hot band force it down evenly to the body of the spring.

Fig. 306.—Handy bolt rack.

FURNACES FOR SHOP USE

The engravings, Figs. 307, 308, and 309, show the Santa Fe practice with oil-fired annealing furnaces, a coke furnace for tempering alloy steel, and oil and water tempering baths. These require little description as all necessary dimensions are given. The annealing furnace will accommodate large work in the annealing chamber above as this is 45 in. long. The plan view at the right shows the grates in position, while the other views show the air blast and the arrangement of the heat passages.

The illustration of the oil and water tempering baths, Fig. 309, shows the method of heating the water in these baths at the left, both the water and steam inlets going down inside the pipe and

discharging near the bottom. There is also an overflow provided to prevent damage.

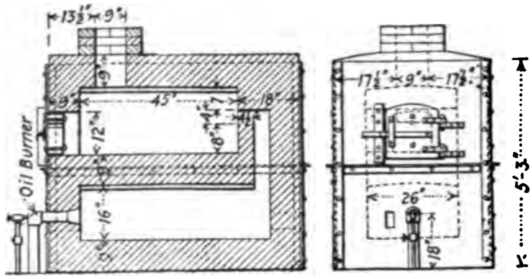


FIG. 307.—Annealing furnace.

In the case of the oil bath it will be noticed that the oil is confined in a center receptacle 12 in. in diameter and made from a

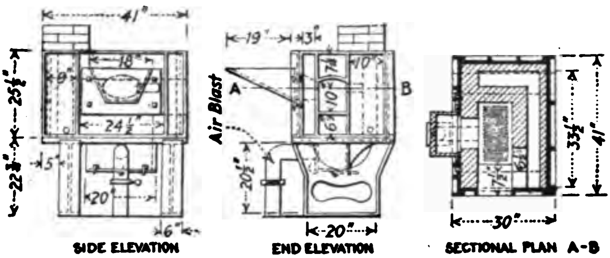


FIG. 308.—Coke furnace tempering baths.

piece of large wrought-iron pipe. This is surrounded by water, so that the oil may be kept cool, the overflow being located in a similar manner to the other bath. The outside of the tank is made of 2-in. planking.

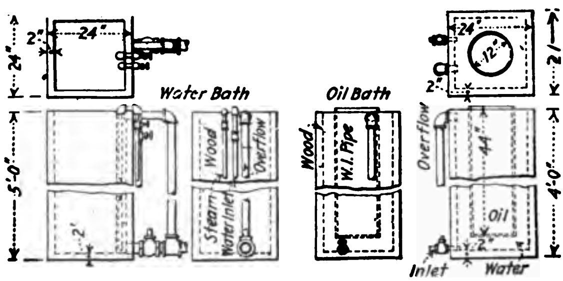


FIG. 309.—Oil and water tempering baths.

CHAPTER XIX

BOILER SHOP AND FLUE WORK

The first engravings in this chapter, Figs. 310 to 317, illustrate some of the methods on boiler work at the Sparks, Nev., shops. While Fig. 310 represents an operation on a boiler part, it is obviously a machine shop illustration, the work having been sent in from the boiler shop for convenience in handling on the vertical boring and turning mill.

The flanged sheet, circular in form and provided with flue, stay-bolt and rivet holes, is shown ready for clamping on the

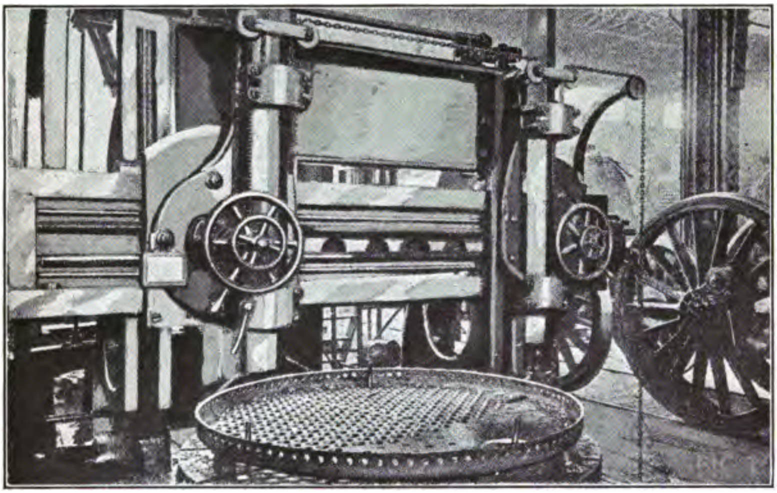


FIG. 310.—Boiler job on the vertical mill.

boring mill table for the operation of squaring off the edge of the flanged surface. The method of locating on blocks on the table and the application of bolts and straps for holding down the work will be apparent upon inspection of the photograph.

Figures 311 and 312 show an interesting application of the oxy-acetylene flame in the process of bending up a flanged sheet, so that the angle of the bend comes in the flanged edges themselves. This bending operation is carried on in the rolls which are squeezed together upon the edges of the flanges to produce the

bend in both flanged portions and in the body of the sheet itself; that is the angle is bent straight across the flat portion and the flanged edges. In order to accomplish this readily, local heating

FIG. 311.—Heating flanged sheet before bending.

is resorted to, by applying the oxy-acetylene blowpipe in the manner indicated in Fig. 311.

The portable apparatus is seen at the right of the bending

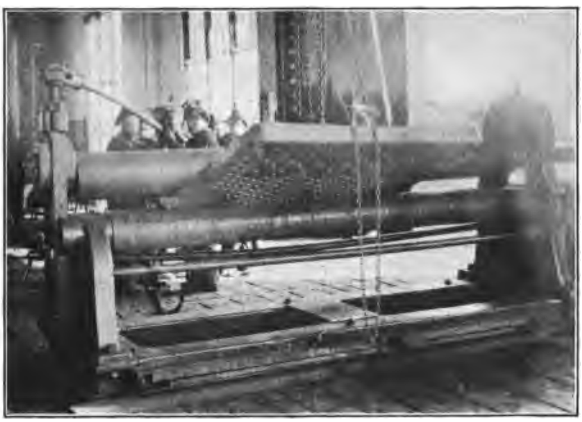


FIG. 312.—Bending the sheet in the rolls.

rolls, and the operator is holding the pipe against the inner edge of the flange at the point where bending pressure is to applied by the rolls. Both flanges are treated in this way until just hot

enough to allow the flanges to bend when the upper roll is screwed down by the long hand lever, which is swung around by the workmen as represented in Fig. 312. It requires but a moment to heat the sheet sufficiently for the purpose stated and very satisfactory results are obtained.

TRESTLES AND SPECIAL SUPPORTS

Figure 313 shows several of the handy trestles or horses used about the plant, one of these at the front of the work and two at each end, the three most conspicuous in the view being all of

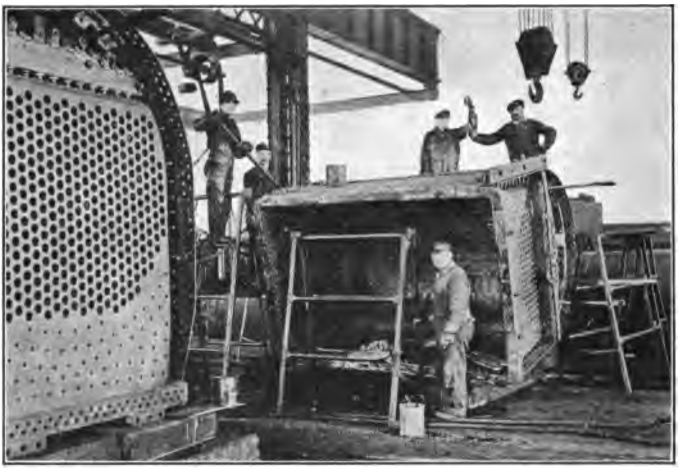


FIG. 313.—Trestles used in boiler shop.

different dimensions, and therefore giving some idea of the various sizes that have been found useful in these shops. These trestles are built up of old boiler tubes swaged along one side to form a flat crescent section which is stiff against bending, and also handy in form for the riveting on of the rungs or crosstying members.

Another convenient piece of boiler shop apparatus is that shown by Fig. 314, which illustrates a sling and hoist carried by another tube-built structure. This support is used for handling and holding various sheets and other members for the convenience of the men working on boiler and tank construction. The structure is swung about to any desired position to suit the location of the boiler job, and can be used for suspending a sheet or other

part in any place required according to the character of the work. The trolley which suspends the hoist carries a large disk at the front, which is provided with a series of holes round the edge in which a locking pin is adapted to fit to hold the trolley proper at any point along the horizontal tube upon which it travels. The structure stands about 19 ft. high and the trolley rail or tube has a length of approximately 10 ft.

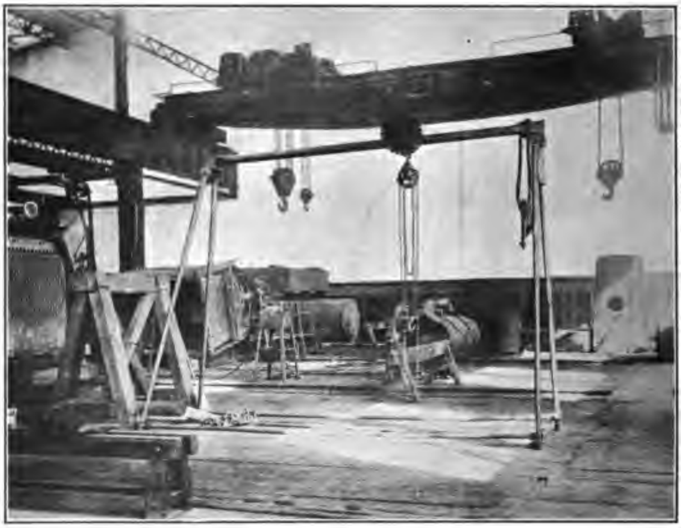


FIG. 314.—Handy portable shop hoist.

LARGE LAYING OUT AND FORMING PLATE

Figure 315 illustrates a laying out and forming plate made of a heavy sheet flanged about the edge and placed upon blocks to bring it to convenient height for the workmen. On this plate, layouts are marked; also work to be bent up is tested for accuracy of angles and dimensions in general by placing upon the outline drawn on the surface of the plate. It is also a form of surface plate for boiler work for laying out directly many pieces and for testing with square and other tools the correctness of such parts when bent up or formed in machines or under the hammer. This plate is very convenient for this work and has saved considerable labor.

Mention should be made here of the very complete system of machine guards applied throughout these shops. Figure 316 is

an example of some of the precautionary measures adopted to prevent accidents to workers about punches, shears, rolls, etc.

FIG. 315.—Laying out and forming plate.

FIG. 316.—Method of guarding punches and shears.

The mustration is practically self-explanatory, but it may not be out of place to call attention to one feature, the height to

which the guard rails are extended above the floor. This height of pipe standards and rails is such as to make it impossible for anyone to walk into contact with belts, gears or pulleys or to touch any of these running parts without carelessness upon his part.

AIR-HAMMER TOOLS FOR THE BOILER SHOP

The full efficiency of air hammers often is not obtained because of the character of the tools which are furnished to operate with

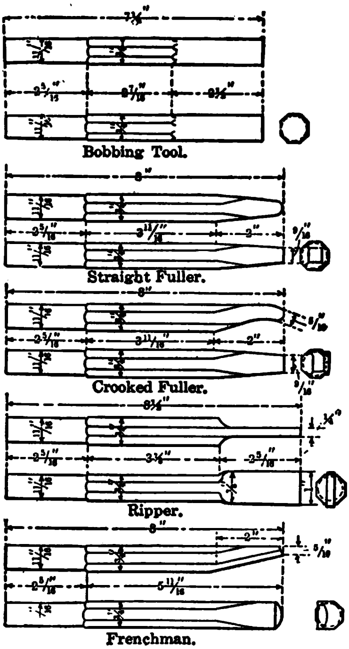


FIG. 317.

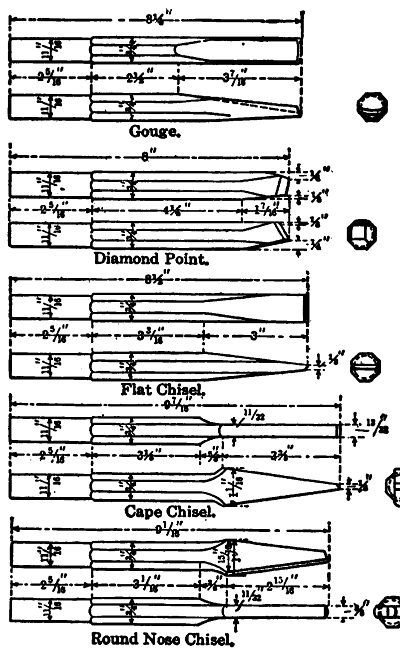


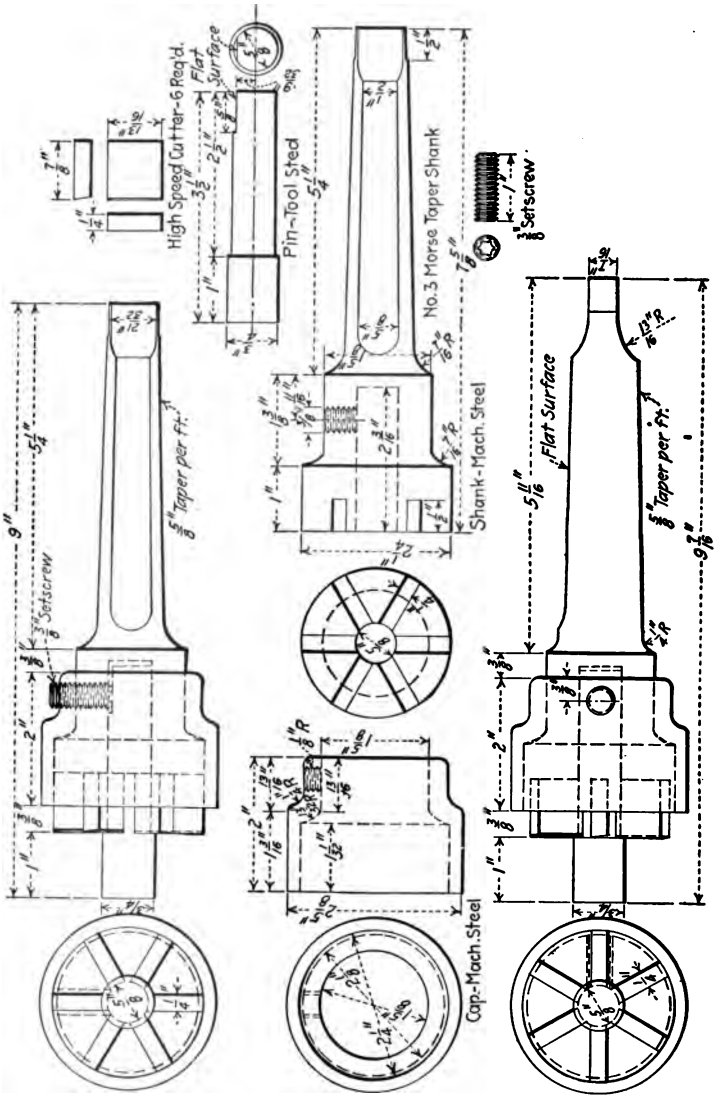
FIG. 318.

Boilermakers' air-hammer chisels.

them. It is not at all uncommon to see a boilermaker with a first-class air hammer and a nondescript assortment of tools, no two of which will exactly suit a job on which he is working. It is also quite common to find each man with his own shapes and sizes of tools. This not only runs into money in steel for a large number of tools, but also causes considerable lost time while the workman waits for a tool to be dressed because he cannot obtain another like it.

The drawings in Figs. 317 and 318 from C. J. Morrison give

a standardization of boilermakers' tools which is used on a large railroad system with satisfactory results.



Scarfing Tool with No.4 Morse Taper Shank

FIG. 319.

Such standardization is readily accomplished in the average shop and makes for economy and production of a higher order.

SPECIAL CHISEL FOR CUTTING STAY-BOLTS

A pneumatic chipping hammer is sometimes fitted up for cutting off stay-bolts in boiler work. For this purpose it is equipped with an attachment for holding a back jaw or anvil which is drawn up against the stay-bolt to be cut off with the chisel. In operation the bolt is cut nearly through with the chisel and then broken off with a blow of the hammer.

MISCELLANEOUS TOOLS

The drawings, Figs. 319, 320 and 321, represent the practice of some shops in respect to certain boiler-shop tools. Figure

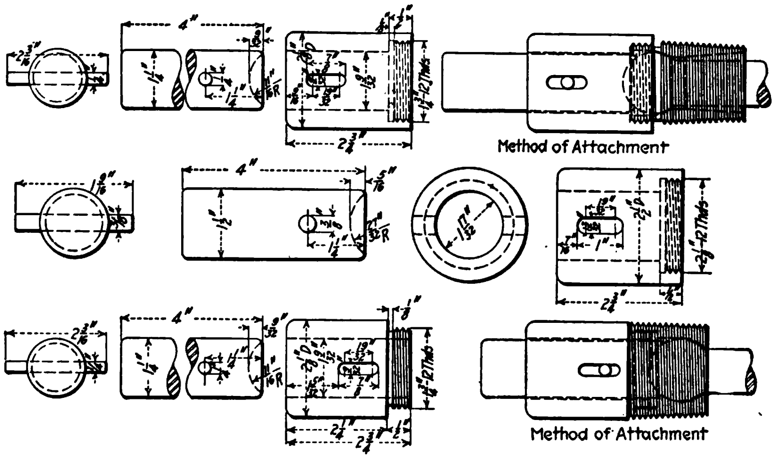


Fig. 320.—Holding on tools.

319 shows scarfing tools for boiler-flue sheet flanges. These tools are made up with six inserted blades of high-speed steel which fit radial slots in the head of the appliance. A machine-steel sleeve fits over the blades or cutters from the rear and this is secured by a hollow head screw which is tapped through the body and also serves as a holding screw for the pilot pin.

Figure 320 shows holding on tools for riveting flexible stay bolts. Full details are given on the drawing, and the method of application is so clearly shown as to require no explanation.

Figure 321 is a diagram showing relation of washout plugs to taps and tap graduations. Four taps make up the set, all 12

V-threads per inch. The graduations from the small end of the smallest tap to the large end of No. 4 or largest tap, are marked from 1 to 12, three graduations to each tap. The diagram at the bottom of the drawing show how the taps are proportioned to overlap from one size of plug to another, each tap thus taking care of some portion or all of the three plugs in its range.

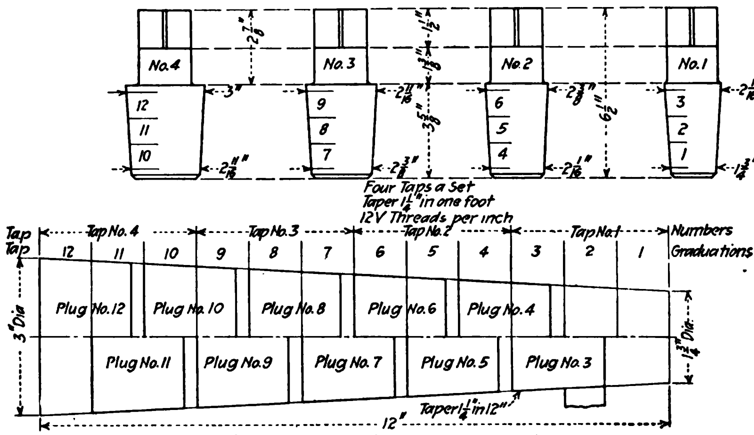


Diagram Showing Relation of Washout Plugs to Taps, and Tap Graduations

FIG. 321.

TOOLS AND METHODS IN FLUE WORK

Referring to Figs. 322 to 326, these illustrate some of the methods and equipment used in connection with flue work.

In Fig. 322 is a view of the flue-tumbling apparatus located just outside the shop building. It consists of a long perforated cylinder to receive the tubes and is provided with power mechanism for revolving the cylinder upon its journals. At one side as shown there is a longitudinal opening extending the full length of the cylinder to admit the tubes, which are hauled up on a car on the inclined track to a point directly in front of the cylinder. At the rear there is a series of inclined rails upon which the tubes fall when the cylinder is opened for their discharge. The tubes roll down these rails onto a car placed on the track below at the left side of the incline in Fig. 322. This track leads directly into the building, so the work is readily handled between tumbler and shop.

Figures 323 and 324 illustrate the roll swager and the pneumatically operated dies for the tube ends. The front view, Fig. 323,

shows a tube just withdrawn from the oil-fired heating furnace at the left and placed in the roll swager at the center of the illustration. At the right is the air-operated swaging die. A better

FIG. 322.—Tumbling rig for boiler tubes.

view of this is given in Fig. 324, with a tube in place for working under the dies.

The machine consists of a short-stroke cylinder and piston

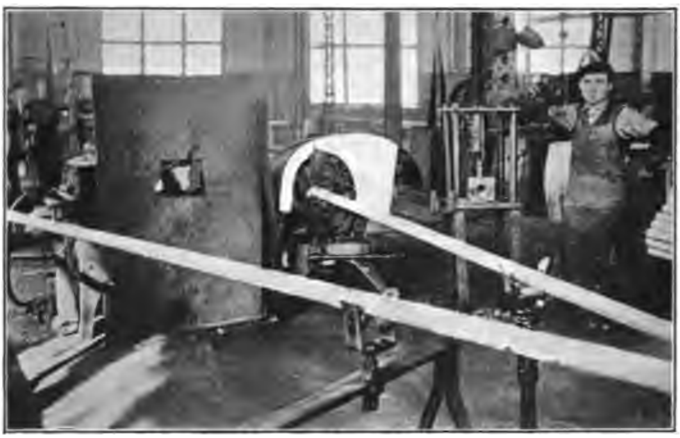


FIG. 323.—Flue heater and swager.

placed in inverted position in a frame built up of a top plate, pipe and through-bolts on an old machine bedplate. The air pipes can be seen at the right-hand side of the structure. The machine is

controlled by pressure of the foot upon a lever near the floor, so that the operator has both hands free to move the tube about under the dies as required for the operation.

FIG. 324.—Tube in the swaging machine.

The machine in Fig. 325 is used for trimming the tubes to length. It is another home-made device built upon a long bed with supporting rollers at each end to receive the tube and hold it in horizontal position for the application of the trimming knife,

FIG. 325.—Trimming machine.

which is a revolving disk 6 in. in diameter. The disk is mounted upon the end of a spindle which is gear-driven from an electric motor at the rear end of the head, as indicated in the engraving. The lever for forcing the cutting or trimming disk into the tube is at the top of the machine with the handle bent forward into convenient position for the operator.

TESTING UNDER WATER PRESSURE

In Fig. 326 is shown the apparatus for testing the tubes under water pressure. The outer end of the tube rests against a closing gasket on a fixture which is adjustably mounted on the long bed of the machine. The outer end is closed by a packing ring in the cylinder head. Water is admitted by the valve near the operator's hand. The tubes as tested are placed on a skeleton truck, which will be noticed immediately behind the workman. This holds a large number of tubes and is of such design and weight that it may be easily moved about with a full load of tubes. It is one of a number of convenient appliances for handling work of various kinds about this repair plant.

FIG. 326.—Testing apparatus.

TUBE TOOLS FROM VARIOUS SHOPS

Tube expanders for locomotive boilers are made in a variety of ways, depending upon shop conditions and the number required. The method used in the shops of the Chicago, Milwaukee & St. Paul Ry., Sioux City, Iowa, is the result of many years experience and has proved satisfactory.

These expanders were formerly made up from sections of wedge-shaped steel, as shown in Fig. 327, held on a mandrel for turning by a binding ring, as shown in Fig. 328. This method has given way to the plan of making them from the solid, the procedure being shown in Figs. 329, 330 and 331.

Round tool-steel bars of the required size are rough-turned and cut nearly through with a parting tool, as shown in Fig. 329.

They are then annealed, chucked and bored till they come apart; or they can be broken apart and then bored to the right taper for the expanding mandrel which is driven into them.

The desired shape is then turned, as in Fig. 330, this varying according to the ideas of the boilermaker. This shop has found it a good plan to make two kinds; one for use when tubes are put in new, and the other for use after they have started to leak and need tightening in the flue sheet.

It has been found that tubes are much more apt to crack and split at the ends, if it is attempted to turn them clear over with a tool shaped as that shown in Fig. 331. In the first tool, therefore, the back, or outer, setting surface is made with a taper of from 40 to 45 degrees. When the tube needs resetting, the

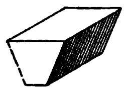


Fig. 327.

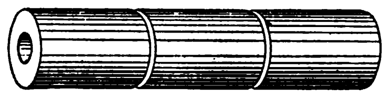


Fig. 329.

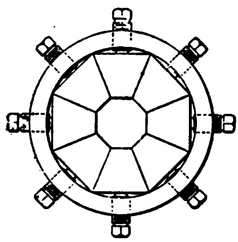


Fig. 328.

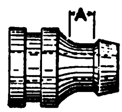


Fig. 330.

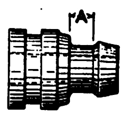


Fig. 331.

Fig. 332.

Boiler-tube expanders and beading tools.

second tool, shaped as in Fig. 331 is used. This turns the tube over at right angles, but does not often split it open, even after the tube has been in use for some time.

After the tubes are turned to the desired shape, they are divided into the desired number of parts and cut almost through with a slitting saw. They are then hardened and broken apart, after which the edges are trimmed smooth and the temper drawn to deep straw or purple.

The number of sections vary; formerly eight sections were always used, but the tendency is to reduce the number to four, though some are made with five. When eight sections are used, the expanding action is probably a little more eveu, but the breakage is much higher.

The shape of the front taper is evidently not important, as

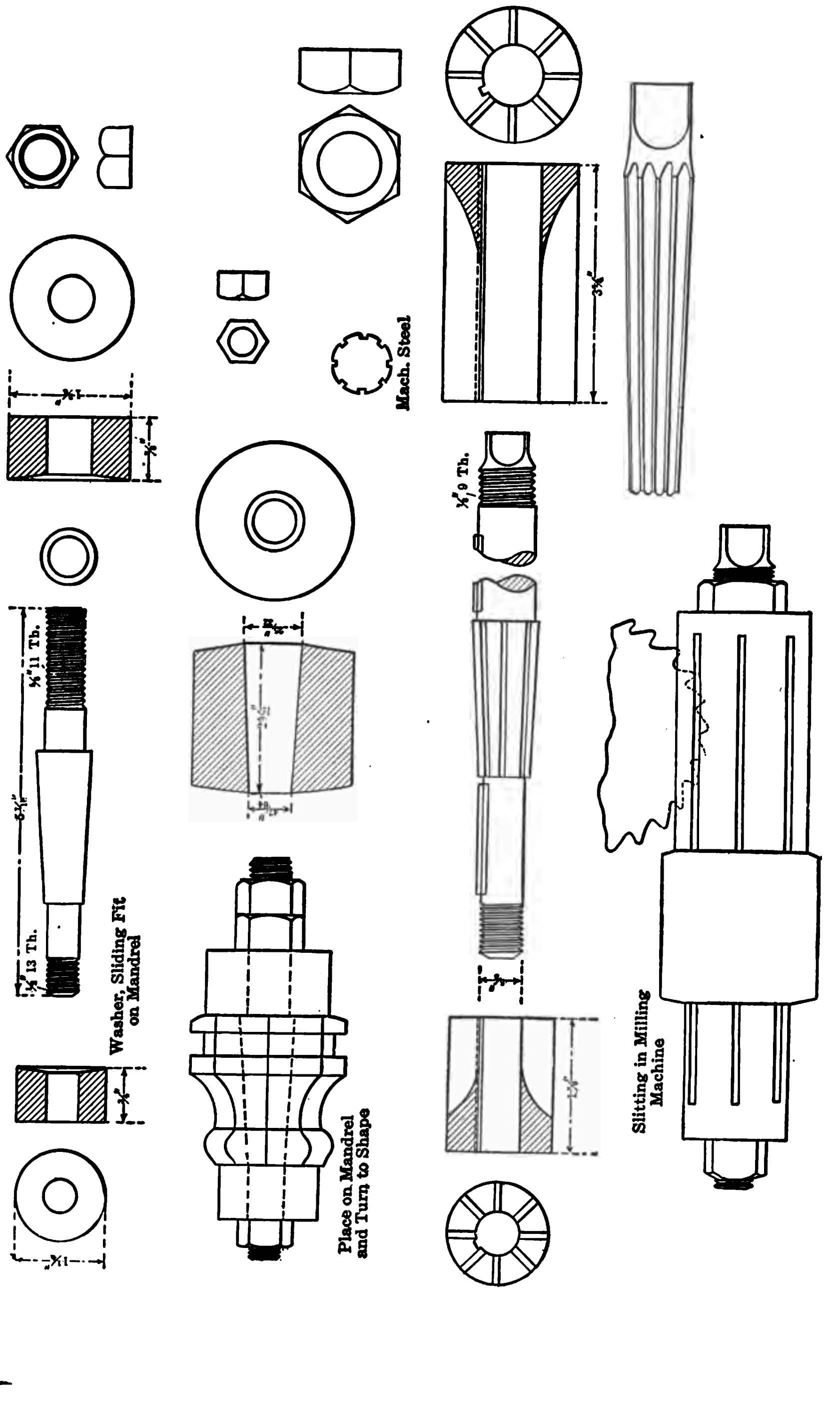


FIG. 333.—Tools for making flue expanders.

this simply enables the tool to enter the tube. The next taper, which expands the tube inside the sheet when it is set out, is about 45 degrees. The distance A between the two tapers which set out the tube on each side of the sheet is $\frac{1}{16}$ in. more than the thickness of the sheet. This is true on all sizes of tubes.

Where the hole is bored round, instead of being made square or octagon, it is, of course, necessary to trim away the outer corners on each piece, as indicated in Fig. 332, or even to grind them approximately flat. Otherwise, the mandrel bears merely on the outer edges, and is not only hard to operate but also tends to split the expanding sections.

Some roads use six-section expanders instead of four or eight, and the general tendency seems to be toward the use of the round mandrel, as being easier to make.

The beading tool is first cousin to the cold chisel, as to material and temper. It is made of octagon cold-chisel steel; one end is turned to fit the pneumatic hammer, the other forged and filed to shape. This is standard, a steel gage being used to file the tool. The temper has to be about the same as a cold chisel—perhaps a trifle softer. The weak spot is the heel, which often spreads and breaks off, due probably to crystallizing under the multitude of blows from the air hammer.

TOOLS FOR MAKING FLUE EXPANDERS

The drawing, Fig. 333, illustrates a method in use at the Clinton, Ia., shops of the Chicago & Northwestern Ry., which was suggested by M. O. Jensen. By this method duplicate parts may be made very cheaply with little skill on the part of the machinist, and the procedure is as follows: Cut from a bar of tool steel of suitable diameter a piece the correct length, drill a hole through the center, ream with a taper reamer, bevel both ends and then clamp it between the hollow washers on the tapered mandrel. It is next placed between the centers of a milling machine and split into eight equal parts with a $\frac{1}{8}$-in. saw, after which the eight pieces are held together between hollow washers in a similar way on another mandrel and turned to the right shape and size.

Parts of expanders made in this way are interchangeable and no care is needed in assembling them. Before this method was adopted, it was customary at this shop to drop forge each section, bevel in a shaper and then sweat the sections together and turn, which was very expensive.

18

CHAPTER XX

TOOLS AND METHODS USED ON STEEL-CAR WORK

In getting out material for steel cars it is usual to order plates and angles in multiples and channels, Z-bars and other structural shapes in cut lengths, specifying a certain allowable variation. For longer members this allowance is considerable, due to the variation in shrinkage while cooling. Stock ordered exactly to length must be cut cold, and the price per ton is much higher than for material cut hot; consequently, it is preferable to take care of this variation on the drawings and get the low price. For example: the 15-in., 33-lb. channels generally used for center sills may be connected to the end sill in such a manner that the excess of an inch over the correct length does not matter. The distance for the rivets are laid out with sufficient space allowed for the material to project beyond the holes without interfering with the other member.

Long Z-bars used for floor stringers and the like are connected in a similar manner. As a result of this care in design and in purchasing materials it is seldom necessary to cut these shapes; if it must be done, the arrangements described will take care of it.

Writing in the *American Machinist,* H. A. Hatfield describes the process of putting the material through the shops as follows: From the stores the greater part of the steel is delivered to the punch-and-shear department to be cut up into the various pieces required for the car. Once in that department, the stock is in the care of the charge hand who directly oversees the shearing. The bill of material informs him of the sizes ordered and what each is supposed to cut. He must check up to see if this is correct. The shear diagram may have been laid out in such a manner that the pieces nest into one another; consequently, it is impossible to shear, as the cuts can only be made in a straight line. He must also consider future operations, especially if the piece is to be bent, since it is preferable that the bend line should be "across the grain," that is, at right angles to the direction of rolling. It is less likely to break if bent in this manner. A partial bill of material is shown in Fig. 334.

Formerly it was customary to mark all stock by hand, but the expense of this operation was eliminated by the development of gages; the quality of the work is better in consequence. For very wide or long material, the number of pieces handled does not warrant setting up a gage. For such, it has been found to be good policy to mark important members, as the web plates for center sills of the fish-belly type, since any adequate arrangement of gages for shearing is too expensive. It also pays to mark the punching while the templet is on the plate. The centers serve as a check on the spacing of the multiple punch. While marking, the templet must always be kept flush with the same end of the stock so that any excess length may be cut off without turning the plate. For this purpose the angle shear may be utilized, as it can be turned on its foundation, and its location in the shop should provide for this condition.

The ends of passenger-car sills are often of a design impossible to shear. In this case the finishing operation is done in a die of the shape required. The machine carrying this die is located at the most convenient place along the line of operations in such a manner that the roller benches serve for two machines. The die is made double so both ends may be formed without turning the plate.

No. Pcs. Order	Mat'l.	Order Size	Cut Size	No. Pcs. Fin.	Name	Remarks		Mk.	Die No.	Draw'g or Forg'g No.	Line No.
					Underframe Construction						
½	O.H.S. plates	50¾x⅜"x5' 8"	21¾"x4' 2¾"	2	Crossbearer diaphragms	Cuts 4	B	1	34"x4'2¾" Cuts 2	E-376	1
½	O.H.S. plates	50¾x⅜"x5' 8"	21¾"x4' 2¾"	2	Crossbearer diaphragms	Cuts 4	B	2	34"x4'2¾" Cuts 2	E-376	2
¼	O.H.S. plates	40x¼"x6' 0½"	20"x1' 6½"	2	Crossbearer cen. sill sep.	Cuts 8	B	3		E-376	3
½	O.H.S. plates	47¾x⅜"x11' 6½"	20½"x3' 11¾"	4	Body bolster diaphragm	Cuts 8	B	4		E-417	4
½	O.H.S. plates	47¾x⅜"x11' 6½"	20½"x3' 11¾"	4	Body bolster diaphragm	Cuts 8	B	5		E-417	5
2	O.H.S. plates	19½x⅜"x5' 0"	19½"x5' 0"	2	Cen. sill bot. cov. pl. at bolster		B	6		E-417	6
2	O.H.S. plates	15x½"x7' 6"	15"x7' 6"	2	Body bolster, top cover plate		B	7		E-376	7
2	O.H.S. plates	15x½"x9' 3½"	15"x9' 3½"	2	Body bolster, bottom cover plate		B	8		E-376	8
1	O.H.S. plates	13x¼"x6' 0"	13"x1' 6"	4	Cen. sill. sep. at str. suppt.	Cuts 4	B	9		E-376	9
½	O.H.S. plates	27¾x⅜"x5' 4¾"	12¾"x1' 2¾"	2	Diag. br. conn. to S. & E. sill	Cuts 10	B	10—12¾"x2'3¾"		E-376	10

Note:—Above plates to be medium grade openhearth steel.

FIG. 334.—Partial bill of material for plates for a steel car.

The importance of the arrangement of the machines is brought out in the preceding paragraphs, and it must be seen that the subject is one requiring a close study of details. In laying out the shear department, provision is made so that the material from the large machines making the long cuts may be handled to the smaller, faster machines with the least possible labor and in the shortest time. Since a contract shop seldom builds two lots of cars of the same type in succession, it is advisable to provide for such changes in the location of machines as may be necessary to handle the type of car under construction, and the type of working floor should be carefully considered from this viewpoint. In an earth floor, cribbing may be used for any but the heaviest machines. Concrete or cement floors should be strong enough to allow the foundation bolts of any machine likely to be moved to be leaded in at any place.

The gate, or guillotine type of shear is used in all parts of the car shop except the forge. The action of the head is vertical, but the blade is set at the angle required for cutting the stock within the capacity of the machine. The shear blades are so designed that all four edges may be used. They should be sharpened frequently, as they do not grind away as fast with sharp edges as when they are worn round; nor is the service as hard on the machine, and the stock turned out is better.

For successful shearing it is necessary that the work be held positively, and an adequately designed "hold down" or stripper is important to the success of this type of machine. On most machines this attachment is actuated by cams on the driving shaft in such a manner that it comes down before the shear blade, holds until the two blades have passed for their full length, and releases immediately. Adjustment is provided so that any thickness of plate within the capacity of the machine is taken care of; or it is possible when the blade is to be removed or a special piece sheared, to lift the stripper out of the way altogether. The holding power may be greatly increased by using wedges between the stripper and the work, and this method is surer and considerably quicker.

In choosing the machine it is well to give considerable attention to the design of the clutch as this is the one great point in the safety of operation, both to the men and stock, and may cause the greatest expense for repairs. It is important that the clutch be safe, not liable to be thrown by the vibration of the machine,

nor stay in and let the machine repeat. In either case the men working at the machine are in danger of getting hurt or valuable stock is in danger of being cut before it can be gotten out of the way. In general, the shear design should be massive, and the center of gravity low. The capacity should be marked in a conspicuous place and never exceeded for any reason.

On the latest machines some provision is made for gages, but the manufacturers have still a great deal to do in this respect and the shear man is mostly left to his own ingenuity for these attachments. By a few simple home-made gages the most complex shapes may be worked out and the operation of marking eliminated.

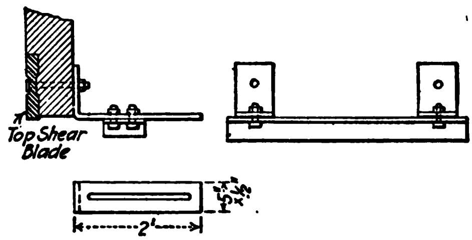


FIG. 335.—Shear gage applied in two different ways.

Figure 335 shows an easily made and applied gage. It is especially adaptable to a large shear. The short angle is used when cutting off narrow stock; different lengths and several pieces may be cut at one stroke of the machine by attaching several of these gages. The two bolts give a better grip and reduce

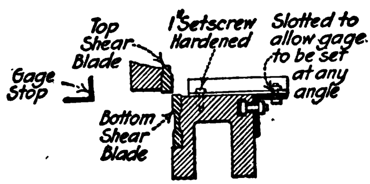


FIG. 336.—Section through machine showing gages attached.

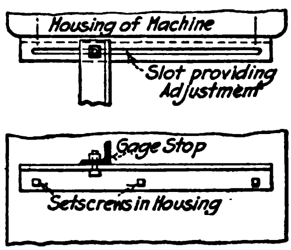


FIG. 337.—Another form of gage.

the chance of moving it. This attachment is always used in conjunction with a T-bolt in the gage slot on the base of the machine, which serves to keep the cut at right angles.

The gage shown in Fig. 336 may be applied to any machine. It was found difficult to keep the set screw from shearing off until a hardened one was tried, which solved the problem. The

design of Fig. 337 is useful where the housings of the machine are reasonably close together so that the gage does not spring.

Channels may be sheared by the method illustrated in Fig. 338. Each blade is good only for one size of channel; large channels should have part of the flanges punched away to relieve the strain on the machine. Z-bars may be sheared by a similar method, but the tool is more easily applied to a punch.

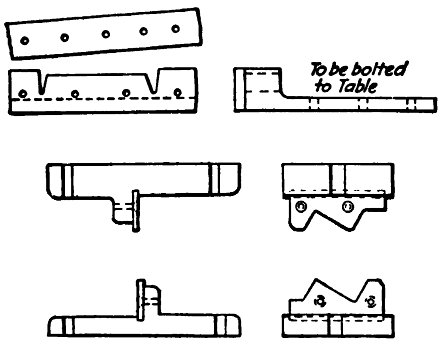


FIG. 338.—Method of shearing channels and Z-bars.

The angle shear lends itself readily to the application of gages. The manufacturer has provided a bar at the back to support the stop. This is all right when the length to be cut is greater than the width of the shear head. For shorter lengths the gage shown in Fig. 339 is useful. It is so arranged that the spring is compressed as the head carries the stop down, but goes back to place as the head recedes and stops in position for the next cut. Considerable difficulty will be experienced in getting good square cuts without ragged edges unless the knives of this machine are kept in first-class shape. The shearing action is partly a punching effect, insomuch as the point of the blade hits the fillet of the angle first and must indent it to whatever extent the fillet is thicker than the legs of the angle before the actual shearing commences.

COPER TOOLS

Since it is expedient to shear in a straight line only, some method for working into corners is necessary. If the piece is of such a size as to make it beyond the capacity of the machine used for blanking or the number of pieces required is not sufficient to justify the expense of a blanking die, the work is done with a coping tool. The pressed shapes used for bolster diaphragms (see Fig. 340) on most freight cars are good examples of the work required to be handled. There is no machine on the market for work of this size and different shops have adapted different machines for their purposes.

One of the best examples of shop ingenuity was the fitting up of an old multiple punch so all operations except shearing and punching the small holes were finished on one machine. The punching attachments were stripped off and the coping die shown

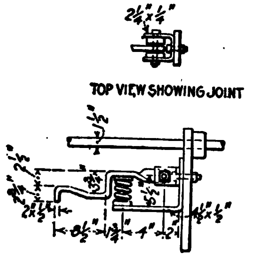


FIG. 339.—Angle shear gage in short stock.

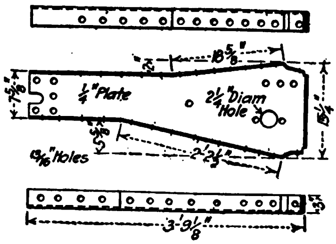


FIG. 340.—Body bolster diaphragm in steel cars.

Coper tools.

in Fig. 341 flanked by two punch dies for the train pipe and the slot to clear the side sill, was put on.

The helper picks up the plate as it comes from the shear and punches the train-pipe hole. At the same time the runner has punched the slot in the small end, and while he is laying the finished piece down, the helper is cutting out the corners that relieve the forming dies when the diaphragm is pressed into shape.

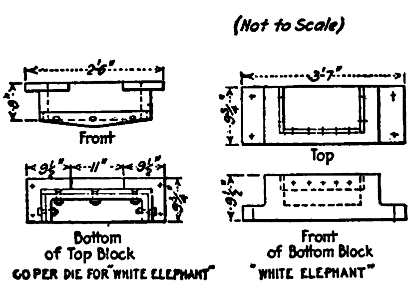


FIG. 341.

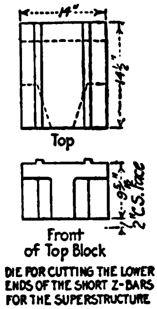


FIG. 342.

Details of dies.

He then hands the blank to the runner and picks up another while the runner is making the remaining cuts.

While intricate shapes may be cut out by simple coper dies, if the quantity required is great enough to warrant the outlay,

it is cheaper to make a die that will produce the piece at one handling. For instance, on the superstructure of a steel-frame box car there are a number of connections for holding the posts to the top side-plate. As cut from the plate, these are of a shape that requires two operations of coping to give relief at the corners for bending. These pieces are easily blanked out at one blow on a properly designed die, and the shearing and coping operations are both saved, while the pieces are more uniform. Possibly a little more material is used than otherwise, as it is necessary for the stock to rest on the lower die all around, but in many cases the pieces nest into one another and the difference is very little, if any. These blanking dies may be applied to any piece, provided the machine capacity required is great enough.

For example, the C. P. R. shops at Angus have dies applied to a bulldozer in the forge shop, that blanks out and punches the hole for the train line in a body bolster. The plates are sheared just large enough to make the blank and two furnaces are used to heat them so that the machine is running practically all the time.

Closely allied with coping is the punching of slots and holes of large diameters. This work is readily handled on a B-punch, and the die blocks, etc., should be so designed that they may be used for both.

One of the most interesting dies used on the steel-frame box car is that for cutting the lower ends of the short Z-bars for the superstructure. This was a job requiring the handling of the material several times, but by use of this die one handling is sufficient. Figure 342 shows the construction.

The die blocks for coper dies are usually of cast iron unless the work to be done is very large and heavy and a sufficient mass of the material to give the necessary strength would be too cumbersome. In this case cast steel is used. The cutting edges are made of carbon steel and bolted in place. Since the work done is seldom equal on all sides of the die and one edge, usually the back, is not used for cutting, the pressure tends to shove the top die over so that it comes down on the lower die. To prevent this an attachment known as the "tail" is put on the upper die. It is longer than the stroke of the machine, and consequently, it cannot get out of place and always holds the die in the correct position. This is shown in Fig. 343.

Gages may be readily applied to these machines, as they may be held by the bolts that fasten the dies to the die blocks or made

of thin material and struck down between the die and block before the bolts are tightened up.

PUNCHING

The adaptation of multiple and gang punches and spacing machine to car work has gradually cut out single punching, except for holes located in a manner impossible to reach otherwise. A recent development is an electrically-operated spacing machine. The templet is long strips of wood in which pins are driven. It is placed on the base of the machine in such a manner that the pins intercept a finger projecting from the carriage throwing a switch, which stops its motion, and at the same time pushes the gag over the punch. The switch is thrown in so the carriage moves again by an arrangement on the head of the machine which hits it as the shaft turns.

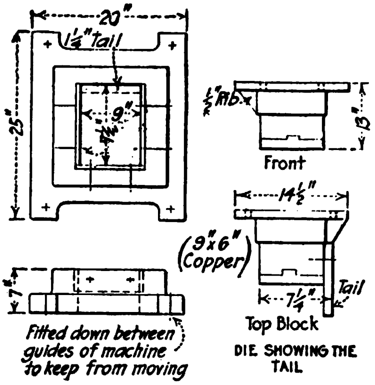
Two holes are punched at once and the machine is particularly useful for punching the flanges of channels and angles. They are placed back to back and held by the clamps.

Long Z-bars are usually punched two at a time in a spacing machine and the punches are so arranged that both flanges can be done at one setting up. Short Z-bars for the superstructure are handled to a gang punch and all the holes in one flange punched at once. The width of the machine is greater than the length of the Z-bars, and it is sometimes possible to arrange the punches for the holes in the web also, when the flange holes are not close together. In this case the punching is complete with two blows and one handling of the material. The jar on the machine is greatly cut down by using punches of different lengths, so that they do not all hit together. Three different lengths distributed equally along the machine in sets are enough to accomplish this.

The web plates for the fish-belly type of center sills, sides of coal cars, etc., are handled on a multiple punch, and the spacing longitudinally is governed by the operator who controls the distance the table travels by means of the spacing device. The spacing across the plate is taken care of by the arrangement of the punches on the machine head, the various gags being thrown in as required. As will readily be seen, this arrangement is not satisfactory for holes so close in line that the distance between their centers is less than the diameter of the punch post, as is the case on the bevel cut of one of these webs.

When the holes are too irregular to get with the ordinary punch

and die blocks, these are taken off the machine and an attachment put on so the punches and dies can be moved together backward and forward across the machine at the will of the operator. This attachment is controlled by a handwheel on a telescoping shaft to which is fastened two small pinions which move the racks that the punches and dies are fastened to. Several punches may be attached to take care of the different sizes of holes, and a complete unit mounted on each side of the machine so that two sills can be punched at the same time.



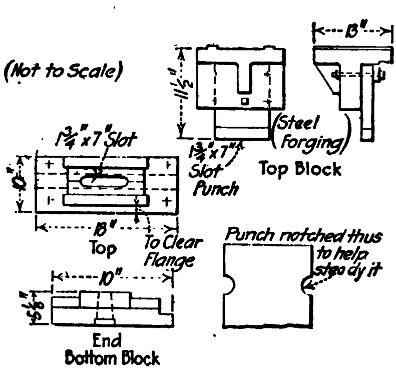


Fig. 343. Fig. 344.
Punch and die details.

Though single punching is inaccurate, slow, and expensive under usual conditions, there are places where it is necessary to be able to punch holes not possible to reach otherwise. Figure 344 shows a slot punch and die.

Flat stock of any kind may be punched on a "profile punch" without any marking. The table is supported on rollers on the carriage so that it can move its own width in and out between the jaws of the machine, while the carriage moves back and forth across the face of the machine one-half the length of the table.

The table is divided in two equal parts. The templet is clamped on one end and the pieces to be punched on the opposite in the same location. A pin on the lever that throws the gag is in the same relative position to the template that the punch is to the work, and the action of sticking it into the holes in the template throws the gag and causes a corresponding hole to be punched in the plate.

This arrangement has been made in two sizes—one for small pieces, one for large. In the latter case the machine used carries two sizes of punches, two pins are required and the templates are made to take care of the distance between the centers of the punches.

The number of holes that can be punched per hour depend upon how many there may be in the work being done, as in some cases the number of pieces handled per thousand holes may greatly exceed other pieces in which more holes must be punched.

OTHER OPERATIONS IN CONNECTION WITH CAR WORK

The line drawings, Figs. 345, 346 and 347, show a bent aluminum sheet for car roofs, and the bending forms made by E.

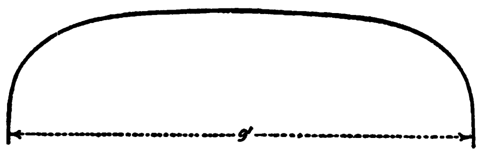


FIG. 345.

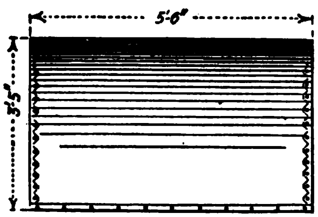


FIG. 346.

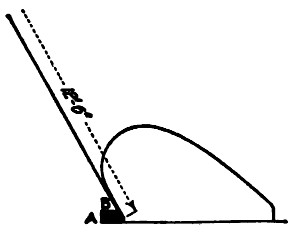


FIG. 347.

FIGS. 345–347.—Improvised sheet metal bending form.

Andrews for the job of forming up these roof plates. There were a number of hard-rolled bright aluminum sheets 12 ft. 6 in. long, 5 ft. wide, 0.080 in. thick for the roof plates of all-metal passenger cars.

The main point made by Mr. Andrews in favor of aluminum sheets for car construction is lightness. A sheet of aluminum 1 ft. square and 0.072 in. in thickness weighs less than 1 lb. (0.995 lb.), while steel weighs three times as much. This reduction in weigh becomes of very great importance, particularly in suburban work, where stoppages are frequent.

In Fig. 345 is shown the contour desired and in Figs. 346 and 347 the side elevation and plan of the bending form. It was the desire to prevent, if possible, any further work being done

on the sheet after bending. Had it been attempted to shape the sheets by some other method, such as with bending rolls or over iron bars, the sheets would have been likely to contain many irregularities on the surfaces. This is especially the case with hammering, for aluminum sheets will not stand anything like the severe treatment that may be given to steel sheets of the same thickness. When thin metal sheets, either of aluminum or steel, are painted for car construction, it is surprising how small defects are readily discernible on the surface.

The efficiency of the bending device enabled the work to be performed quickly, and exactness of contour was obtained without blemish. The cost of this form was very small. In fact, it paid for itself the first day.

It was simply constructed of steel sheets 1/16 in. thick. Three pieces were required—two pieces for the ends and one for the center portion. They were cut to the required shape and dimensions, the center piece being bent to the contour of the side pieces and secured to them by 1/4-in. cup-head bolts. The ends were notched and then flanged at right angles on the inside for this purpose. The bottom edges were flanged at right angles on the outside, for fastening to the wooden floor by screws. A piece of wood was fixed to the floor as shown at *A*, Fig. 347, to prevent the turned-up edge or groove from damage and to support the process of bending.

A cast-iron bending block was at first suggested, but this would have necessitated an expensive wooden pattern in addition to the cost of a heavy casting. Then there was the inconvenience of having to wait several weeks for its delivery, whereas the sheet-metal bending form, with its simplicity and cheapness, enabled bending the aluminum sheets on the following day. It was necessary to employ two workmen to manipulate the sheets satisfactorily, owing to their large dimensions. One end of a sheet was put into the groove, as at *B*, Fig. 347, and worked over the form as far as possible. The roof sheet was then taken out of the groove and the opposite end treated similarly.

STEAM AND AIR CONNECTIONS FOR RAILROAD YARD

The illustration, Fig. 348, by Joseph K. Long, shows a new method of fitting up coach yards with adjustable steam and air connections. Formerly there was much trouble due to steam hose bursting or blowing off when long pieces of hose were used.

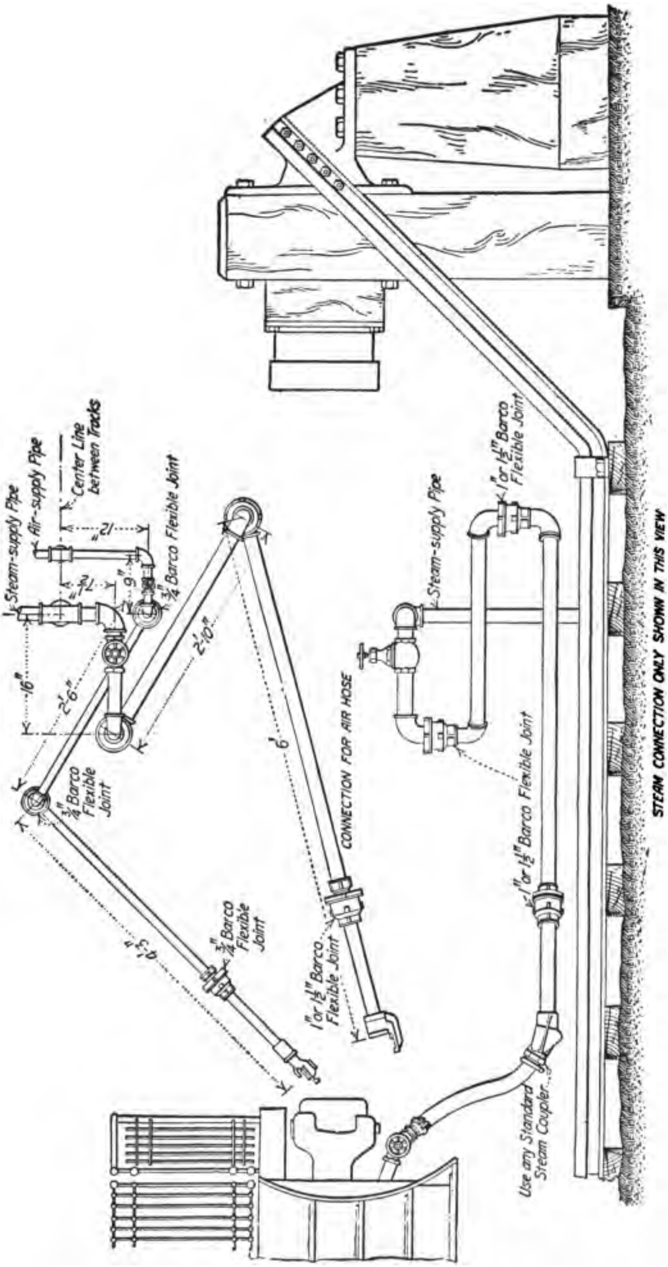


FIG. 348.—Steam and air connection for railroad yard.

In the upper part of the drawing the air and steam lines are shown in plan view. Where the lines come out of the ground there is a T, and this is piped to two tracks, one on each side. When two tracks are to be fitted up, the lines look best if supply pipes come up directly between the two tracks, and both will be equally well taken care of and the lines will be as efficient if both are fitted up with the same length of pipe to each track. Pipes of the length indicated in the diagram have a range of about 5 or 6 ft., and it is an easy matter to place the cars on the track or siding inside that range of space.

The arrangement permits of considerable extension, and when not in use it can be folded into a very small space. The joints should always be put at right angles to the pipe, except where a third is necessary. Where the joint is on the coupler end, it may be put in line with the pipe and 12 to 18 in. from the coupler if desired. Barco flexible joints are used in this work, and they can be moved in any direction with this combination. It will be noticed that the globe valves are near the source of supply from the ground line.

This arrangement will also be found useful and satisfactory for unloading tank cars and wagons, filling them or conveying steam to heat coils in the tank cars, where heavy oils must be heated before unloading. This plan here described should be doubly interesting during cold weather, as a device of this nature is necessary in order to properly take care of coaches, the old method of using hose having proved inefficient.

PAINT SHOP SCAFFOLD

Figure 349 illustrates the interior of the paint shop at the Panama Railroad plant, Balboa, Canal Zone, and shows particularly a very convenient arrangement of scaffolds for car painters and varnishers. These scaffolds are broad platforms suspended at either side of the tracks by vertical columns that telescope into hollow members hung from the roof chords. The scaffolds or platforms, are in lengths of some 12 or 14 ft. and form a continuous runway along the side of the car. Each section is independently counterbalanced and may be easily raised or lowered to any desired point by hand. The supporting columns of steel are provided with locking points at close intervals and a lever for each column controls the detent by which the scaffold section is rigidly held when set at any desired height.

With this arrangement the scaffold sections may be kept at uniform height for the entire length of the car or any section

Fig. 349.—Adjustable staging for painters in car shops.

may be elevated or lowered independently of the others, thus permitting the workman to readily adjust their positions to suit the work to be done.

CHAPTER XXI

WELDING OPERATIONS ON LOCOMOTIVES AND CARS

The subject of welding as applied to engine and car repairs is extensive enough to fill a complete volume of itself. Consequently it is impossible in a single chapter to do more than refer briefly to some of the many interesting methods employed in the carrying on of such work in the railroad repair shop.

OXY-ACETYLENE WELDING IN LOCOMOTIVE REPAIRS

Oxy-acetylene welding is essentially repair work but the process is well suited to many operations on new work as well. In locomotive work its use is widely extended and many iron and steel castings and forgings are repaired in this manner at an expense much less than the cost of renewal. Worn parts, such as links, eccentric blades, crossheads, pistons, valve rods, truck and trailer hangers, and waist sheets are repaired with a consequent saving of time and money. Writing on this subject, H. W. Jacobs of the Santa Fe system shows many examples of parts of this character successfully welded by the above process. Repairs to steel cabs, steel running boards, ashpans, tender cisterns, air and oil reservoirs, and all locomotive sheet-iron work can be expedited and made at a reduced cost by the process. New work of this nature can be made without joints at reduced initial expense and not unlikely reduced maintenance. With a sufficient supply of gas to permit continuous operation at the necessary pressure, main frames can be welded in position, patches can be applied to broken cylinder castings, cracked bridges in valve chambers can be repaired and broken spokes welded in driving wheels.

The advent of steel construction in passenger coaches and freight cars offers unlimited opportunities in the car shops for the application of autogenous welding. The process is especially suited to the welding of the thin sheets of the head lining or siding and the application of bracing at the window framing in the all-steel coach when built new; this is also true of patch work when these parts are in need of repairs.

Repairs to the body of steel freight cars can be handled in many instances to better advantage by the oxy-acetylene blow pipe than by the air hammer. This is also true of many repairs to steel underframes.

In working over wrecked equipment of steel construction, many parts are consigned to the scrap pile due to the high stripping cost. These parts can be saved by the employment of the cutting-off burner.

In the machine shop the oxy-acetylene flame is extremely valuable. Repairs to machines are handled economically and with despatch; imperfect castings due to blow or sand holes are reclaimed; broken dies for either machine or steam hammer are built up where worn and redressed; teeth are renewed on gear wheels, and a variety of work of similar nature is handled with a consequent saving in time and labor.

Continuing, Mr. Jacobs shows a number of welding jobs from the Topeka shops, the views covering only a part of the work now handled by the oxy-acetylene process.

ILLUSTRATIONS OF TYPICAL JOBS

When piston rods become loose at the crosshead fit renewal is necessary under the old method. By building up the fit autogenously, Fig. 350, and returning at an expense of a few dollars the old rod is made serviceable and there is a net saving of several dollars for each rod repaired in this manner.

FIG. 350.—Piston rod renewal eliminated.

In building up the crosshead fit on a piston rod, the rod is heated in the forge previous to the use of the blowpipe, Fig. 351. The work can thus be handled in shorter time and at considerably less expense.

Links become worn either by the eccentric blades or blocks, Figs. 352, 353, 354, making renewal necessary under the old method. By building up the worn places with the autogenous welding the necessity of supplying a new link at a much higher cost is removed.

Figures 355, 356 shows a part of a reverse lever badly worn (on the right) from contact with a single-bar quadrant and the lever

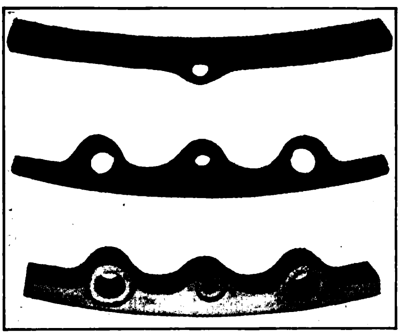
after having been built up by the autogenous process (on the left). The necessary blacksmith machine and bench work to renew this part of the lever would have amounted to three times the autogenous welding and refitting cost.

Fig. 351.—Building up a crosshead fit.

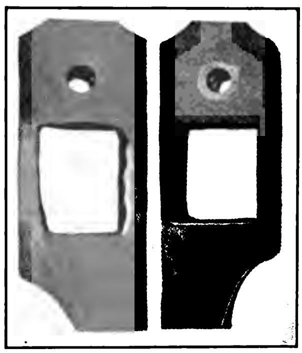
When the teeth on a reverse lever latch, Fig. 357, become worn it is necessary to replace the latch with a new one, while the use of the autogenous process permits the building up of new teeth at small expense.

The teeth in quadrants become worn and broken, Fig. 358, making it necessary by the old method to insert new teeth by dovetailing. With the autogenous process two new teeth can be built up and dressed at a saving, and the quadrant is considerably stronger when repaired autogenously than by dovetailing insertions.

Two steel cylinder heads, Fig. 359, were badly bent and cracked in a wreck, making it necessary to renew them. By welding them autogenously at a total cost of a few dollars the expenditure for two new heads was avoided.



Figs. 352, 353, 354.—How links are built up.



Figs. 355, 356.—Reverse lever built up.

A rod strap, was so badly worn that it would have been necessary to use a new one. By building up the worn places through the autogenous process the strap was made entirely serviceable at a total cost of less than one-quarter that of the new strap.

Air hammers become cracked in the arch and can be welded by the autogenous process at a net saving of 90 per cent over the price of a new handle.

The head for a 24-in. shaper was badly cracked at one end, and also had a broken lug. This head was welded at a saving of several dollars as compared with the price of a new head and the machine was out of service less than 1 hr.

The back ends of the frames become badly worn on the top and inside from the working deck casting, Fig. 360, making it necessary to remove the frame and fittings, and to have the frame reinforced at the blacksmith shop, machined, and replaced. With the autogenous process it is not necessary to remove the frame.

FIG. 357.—Reverse lever latches. FIG. 358.—New teeth built up in a quadrant. FIG. 359.— Steel cylinder heads.

LOCOMOTIVE FRAME REPAIRS

In a paper before the Master Blacksmiths' Convention, (1919) P. T. Lavinder of the Norfolk & Western brings out some interesting points on frame welding as follows:

At the Roanoke shops of the Norfolk & Western, the following method of repairing frames is being used with great success: It was formerly the practice to use electric welding exclusively in repairing locomotive frames with the exception of welds made in the smith

shop forge. In making electric welds the procedure was as follows: The frame was cut from both sides at angles of approximately 45 degrees. The frame was expanded from $\frac{3}{32}$ to $\frac{5}{32}$ in. depending on the size of the frame; using a portable grinder on the scarf where the weld was to be made, cleaning it to secure good bright metal. Welding was begun at the bottom of the scarf, one operator working on each side of the frame. Care was taken to keep the weld free from oxidization and scale as much as possible, by the use of a wire brush, and when the weld was completed it was annealed.

FIG. 360.—Repairing a main frame.

The Roanoke shop has made 19 oxy-acetylene welds on locomotive frames in the past 60 days. This is the first frame welding done at this shop by this process. No failures have been reported up to this time, and it is believed this method will prove very satisfactory. In making welds by the oxy-acetylene process on locomotive frames the following method is used: First, the frame is trammed over the break with a long tram, care being taken to use a tram long enough to keep clear of the heat. Second, the frame is cut from both sides in a V-shape at angles of 45 degrees. Third, the portable grinder is used on the scarf, where the weld is to be made, cleaning it to good bright metal. Fourth, the frame is spread for expansion allowing $\frac{1}{4}$ to $\frac{1}{32}$ in. according to the size of the frame. Some acetylene welders allow far less expansion than others, but we believe that a frame welded a little too long is much better than one too short. More expansion should be allowed when a furnace is used around the frame for preheating purposes. Fifth, the expansion blocks are covered with asbestos in case they are liable to get hot. Sixth, a piece of boiler plate is cut and placed under the frame at the location of the weld. Seventh, the frame is heated with a welding blow pipe or preheated with an oil burner. Eighth, welding is started at the bottom of the scarf, the operator on each side of the frame bringing the metal out to the desired thickness and proceeding up the scarf. This

is necessary as a welder should never go back over a weld to apply more metal. When the weld is practically completed the spreader block is removed. This is necessary as the weld is getting shorter just as soon as welding stops. If a lower rail is to be contended with, it should be heated to a good cherry heat, thus allowing the top and bottom rails to contract evenly, removing all strains. Expansion and contraction must be governed by the welders, as some welders are faster workers than others. Frame welding, whether by the electric or oxy-acetylene process, should be done by the most competent operator avaiable as the success of the work depends entirely upon the operator.

In conclusion Mr. Lavinder recommends that when an engine comes into the shop for heavy repairs and the frames have been welded four or five times, the frame not having been taken from under the engine at the time the welds were made that the frame should be taken down and put in the smith shop. All welds previously made while the frame was under the engine should then be cut and worked over and the frame made to proper dimensions. One leg of every brace should then be heated midway between the top and bottom of the rail to a red heat. By this method all strains in the frame that have been caused by welding or otherwise will be released.

CYLINDER WELDING

One of the important fields for welding is in the repairs of locomotive cylinder castings. Discussing this subject before the General Foremen's Convention L. A. North of the Illinois Central Railroad stated that it has been possible to weld cylinders which formerly would have been scrapped or repaired with either a brass patch or a dovetailed insert of some other metal, the weld in the majority of cases making a substantial and satisfactory job provided the expansion and contraction had been properly taken care of. It has been found through experience that in order to properly weld a locomotive cylinder, or a casting of any make or design, it is necessary to preheat thoroughly to insure a uniform temperature in order to properly take care of expansion and contraction and to avoid cracking after the weld has been made and the metal has been allowed to cool off. The success of any weld of this kind depends largely on the care used in the preheating and the judgment of

the operator making the weld. One cannot be too particular in the selection of the operator for this class of work.

One difficult weld coming under observation was a case where the entire upper portion of the cylinder at the port area had been totally destroyed. This was repaired by having a gray iron patch cast in the foundry, fastened to the cylinder by means of clamps and welded in place. The cylinder was preheated to uniform temperature to take care of expansion and contraction. After the weld had been made and the cylinder had cooled down, a reinforcement was added to this weld by drilling through between the stud holes and securing the additional support by tap bolts which were tapped and screwed into the main barrel.

It is possible to weld broken bridges in slide valve cylinders successfully. Recently this was done and effected a saving of two cylinders in place of the one, which was cracked, as the cylinder which was repaired was an obsolete pattern and had we not been able to make this weld, the application of an entire pair of cylinders to this engine would have been necessary. As this engine was one that in a few years will be placed in the scrap pile, it is probable that the weld will outwear the present cylinders.

SAFETY INSTRUCTIONS FOR OXY-ACETYLENE APPARATUS

The following instructions for handling oxy-acetylene gas are strongly recommended in a paper by E. Wanamaker of the Rock Island lines, before the Railway Fire Protection Association:

In handling acetylene gas in tanks under pressure it should be remembered that at no time should the tank be allowed to remain near stoves, furnaces, steam radiators or any other sources of heat, nor should they be exposed unnecessarily to the direct rays of the sun. Care should also be used in handling acetylene gas containers to avoid heavy jars. It must be remembered that any steel drum is liable to mechanical injuries if not reasonably handled. Acetylene cylinders should always be stored in an upright position with the valve end up. Leaking containers should never be used and should one be found, it should be set out in the open air as soon as possible away from all possibility of ignition of the gas or of the mixture of gas and air that surrounds the container.

Open flame lights should never be taken into confined spaces where there is any possibility of leakage of acetylene. In case

it is found necessary to use an acetylene tank in a small enclosed space a little air should be blown into the space from an air hose in order to secure a good circulation of the atmosphere. All acetylene containers should have fusible plugs. Neither oxygen nor acetylene containers should ever be allowed to remain where they are exposed to sparks or flame.

Oxygen containers should not be dropped nor handled roughly in any way and should not be placed where they may be overturned by a collision with other objects or by reaction caused by the violent escape of their contents through the safety outlet with which containers should be provided. The regulating devices, valves and other attachments on oxygen containers should never be lubricated with oil or grease. Whenever lubrication is required it should be secured by the use of pure graphite unmixed with either oil or grease. Furthermore the discharge valves of oxygen tanks should always be opened slowly and care should be taken to avoid twisting or straining them by the use of hammers or improper wrenches.

The hose and hose connections used between the gas manifolds or gas tanks and the welding torch must always be maintained free from leaks and all joints made mechanically tight and secure. The regulating valves and torches must be kept in a good state of mechanical repair to avoid leakage of the gases. No part of the equipment to which hose is attached should be used without securing the hose with the proper size hose clamp. Wire fastenings should not be used in any case. In case of any trouble with the torch the gas should be immediately shut off at the tanks or pipe line station.

Where generating stations are used the instruction cards sent with the parts must be carefully followed and no leaks must be permitted on any of the pipe lines. No man should be permitted to use the gas welding torch until properly instructed by a welding supervisor or some experienced welder and if he is not the regular operator permission of the foreman in charge should be obtained before the machines are used.

Safety gages should be used on all regulators, that is, gages having loose or vented backs, so that in case the pressure on the gage builds up to a dangerous degree or builds up too rapidly, such as might cause a rupture of the Bourdon tube the force will spend itself without breaking the glass case, thereby causing possible injury to the operator.

Some shops use portable welding outfits, purchasing tanked gas and tanked oxygen. Other shops install acetylene generating outfits, also oxygen generating outfits, piping the gas throughout the shops having manifold outlets to which the hose from the welding torches are connected. Still other shops generate acetylene gas and purchase tanked oxygen, connecting it to a manifold which in turn is connected with a system of piping in much the same manner as the oxygen generating plant. Each generating plant that is installed is equipped with a complete set of instructions for intelligently operating the generator, the most important of which are: "Remember to keep all light or fire of any kind away from the plant and never permit the generator to remain more than five minutes unless the generating chamber is filled with water, even when it is not in use." If the instructions that we have given in this paper and the detailed instructions which are given out with the generators are carefully followed out and leaks of all kinds prevented in the distribution piping system of the installed plants, there will be practically no danger from fire.

ELECTRIC ARC WELDING IN PENNSYLVANIA SHOPS

The following data on electric welding in the Juniata and Altoona shops are from an account by Robert Mawson.

In the arc welding process the necessary joining material is in the form of a metal welding rod that is melted by the heat from the current passing through the tips or contacts. This is allowed to flow on to the pieces to be welded until a homogeneous weld is produced. This method is somewhat similar to oxy-acetylene or flame welding. On many parts the preparation for the weld is similar for the two processes, and care is necessary to obtain the desired successful results.

At the Juniata and Altoona shops of the Pennsylvania Railroad arc welding has been used for the past several years on many manufacturing and repair jobs. Arc welding of parts that are under stress or that carry loads is not permitted so the application has been carried on somewhat slowly. Yet with these limitations, many uses are found on every day jobs for the arc welding machine outfits that are employed in these shops.

One of the uses is for welding the tubes in the sheets of boilers, and now all locomotive boilers are assembled in this manner. In service it has been found that if the welds are correctly made,

they scarcely ever give trouble through leaks. Some engines with boilers so assembled have been kept in service for two years, and when tubes were removed the welds were found to be as good as when originally made. There is, however, this to say for the operating practice of the Pennsylvania Railroad. The water used in the locomotives, with the exception of that found in one or two localities, is of a very good quality and does not tend to injure the tubes or the welds.

Two makes of arc welding outfit are used at these shops; these are made by the General Electric Company and by the Siegmund Wenzel Company. The current pressure is from 60 to 65 volts and the flow about 150 amp.

FIG. 361.—Welding tubes in a boiler.

In Fig. 361 is shown the boiler of a locomotive with some of the tubes welded and others prepared for welding. In number there are 265 of the 2-in. tubes and 36 of 4⅝-in. size. These tubes are placed through the machined holes in the sheet and allowed to project 3/16 in. The projecting end is then beaded down as far as possible against the outside surface of the sheet. The tubes shown at the right of the illustration have been treated in this manner. The ends of the tube are then welded to the sheet. Those shown to the left in the illustration have been thus welded. The welding rate for the smaller tubes is 15 per hour and for the larger 8 per hour.

The spools used for engine valves are also built up with the aid of the welding machine. These spools are made in four parts,

two bell-mouthed centers and two end pieces, as shown in Fig. 362. The parts of the spool which are held together by a bolt through the inside and by straps at each end, are welded in three places *A*, Fig. 363. Metal is then added to the two outer surfaces *A* of the flanges, Fig. 364, so that the spool will be sufficiently long for the facing operation. The piece measures 24 in. in length, the flanges are 11⅝ in. in diameter, and the diameter of the center is 5½ in. The wall is 0.148 in. thick and the spool is made from steel tubing. The welding time is 3½ hr.

A special welding job done in the shops is a tank used to hold babbit, Fig. 365. It is shown as the next example. This tank

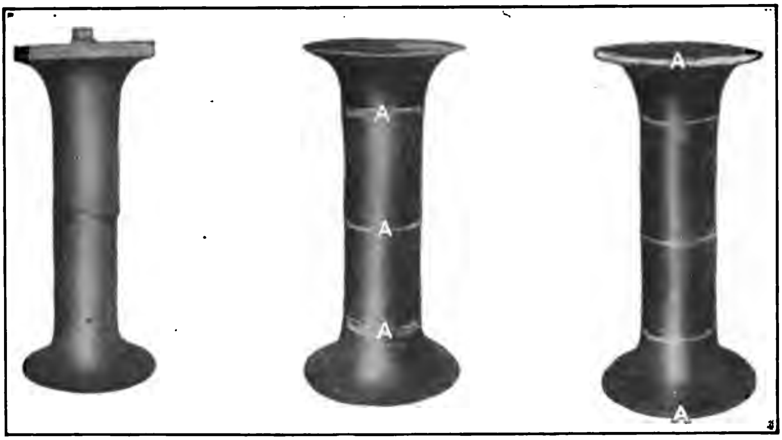
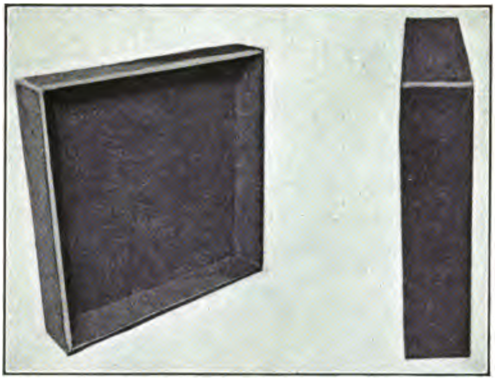


Fig. 362.—Assembling a valve. Fig. 363.—Second operation on the spool. Fig. 364.—Completely welded spool.

is 36 in. square and 8 in. deep, made from ½-in. steel plate. Welds are made along the four corners to form a tight receptacle. The corners are assembled with butt joints and simply "tacked;" afterward the welds are completed. By this method the plates do not require to be bent at the corners, and riveting is avoided. The time required for the tacking and welding of the four corners is 3 hr. In Fig. 366, an end view of the tank, the appearance of the welds may be better seen. Another use of the apparatus is for what was at one time considered an impossibility, a putting-on tool. Not many years ago if a part was undersize through wear or a mistake in the shop, it was scrapped. Sometimes it was made usable by another machining operation. In Fig. 367

is shown the result of a putting-on operation on the end of a piston rod. This rod end was worn down considerably in service and it was necessary to enlarge it to effect a repair. The enlarged



Figs. 365, 366.—Welded babbitt tank.

end A measures $5\frac{3}{16}$ in. in diameter and is 9 in. long. The undercut surface B is $4\frac{5}{8}$ in. wide. Metal was added to the surface A to a depth of $\frac{1}{2}$ in. The time necessary for the operation was

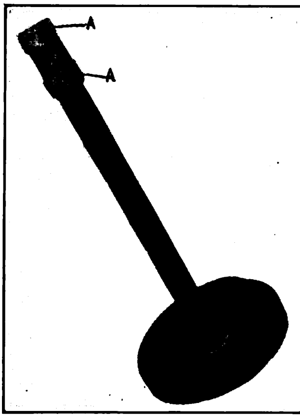


Fig. 367.—Putting on metal on a piston rod.

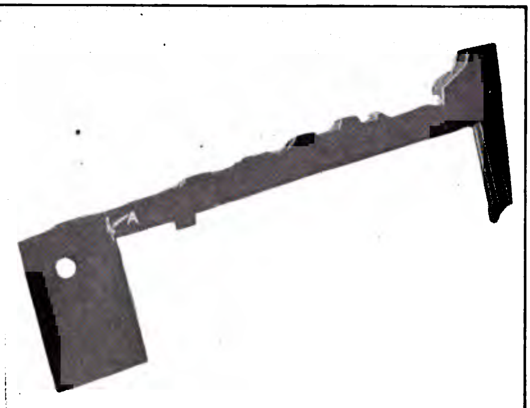


Fig. 368.—Repairing a cab saddle.

3 hr. The rod is ready for the lathe where the surfaces to which metal has been added will be turned to the required dimensions.

The electric welding outfit is suitable for other kinds of repair

work. In Fig. 368 is shown a broken cab saddle, made of cast iron, which has been welded on at *A*. At the point of fracture the piece measures 8 in. wide by 1 in. thick. The weld was made in 30 min. The other way to make such a repair would be to place plates on each side, drill through the entire assembly and fasten the parts together with rivets.

PRECAUTIONS

In working with the electric arc the eyes must be thoroughly protected from the light to prevent serious burns to the interior of the eye. A mask used consists of aluminum fitted with colored protective glass, which should be sufficiently dense to prevent a degree of light intensity objectionable to the eye. There should be no holes or openings in the mask or around the joint where the glass window is placed, as even the small amount of light thus admitted would become injurious to the eye. The inside of the mask is painted dull black.

MISCELLANEOUS WELDING OPERATIONS

Figures 369 and 370 illustrate a job of oxy-acetylene welding at the Sparks shops; the work being a driving wheel cracked in the boss. The wheel was preheated for a couple of hours before starting the welding process, the method of heating being shown in Fig. 369, where a steel plate will be noticed over the portion requiring heating and over the plate a body of coke, so that the heat from below was well confined to the immediate area around the crack, the latter being chipped out to form a narrow gap for the weld prior to starting the fire. Figure 370 shows the application of the welding torch and rod to the work.

Figure 371 illustrates the autogenous welding of a crack in a yoke on an engine in the roundhouse. Figure 372 shows the method used by the Southern Pacific shops at Sacramento in preparing a frame for welding. Here a portable power hacksaw is shown in operation on the frame, cutting out a piece of metal along the crack. The saw is adjustable to either horizontal or vertical position and is operated by an air motor.

This shop makes numerous oil welds and in using the fuel-oil process on frame work, they first cut out the cracked portion of the frame, then build up a portable firebrick forge for heating around the cracked portion of the work. The firebrick are built

Fig. 369.—Preheating the driving wheel for welding.

Fig. 370.—The welding operation.

Fig. 371.—Welding a cracked yoke.

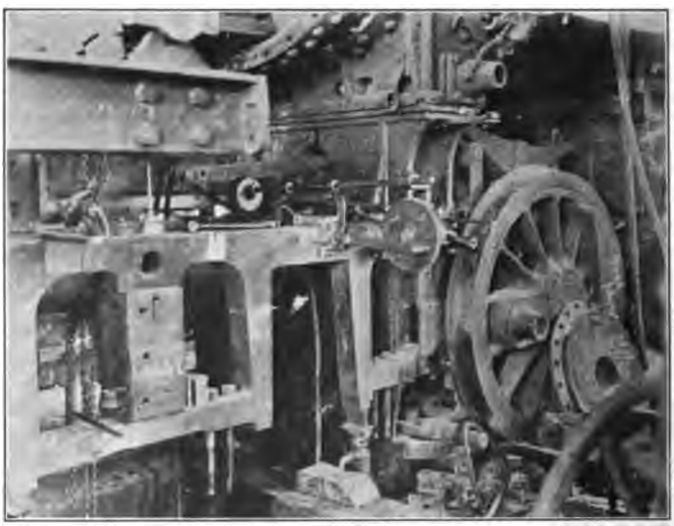


Fig. 372.—A power hack saw used in cutting frame before welding.

up with iron angles at the corners and through-bolts are used to hold all together when completed. The brick walls are left with openings at the sides for insertion of the oil burners and also for the application of heavy pneumatic hammers which are applied from each side to the portion of the frame being welded.

After the saw has been used to cut out a thickness of metal, say $\frac{3}{4}$ in., and the work is thoroughly heated, a piece of welding metal $\frac{1}{4}$ or $\frac{5}{16}$ in. thicker than the cut is put in place and heavy tie rods are applied to the frame to draw the gap together as the welding is done.

CHAPTER XXII

RECLAMATION WORK

The illustrations in this chapter show some of the important features of the work of reclaiming scrap material in railroad shops. While every shop does more or less work along the lines of reclamation, few have such opportunity in this direction as the Southern Pacific general shops at Sacramento, for this plant has its own rolling mills where large quantities of scrap which it would be impossible to reclaim otherwise are put through the

Fig. 373.—Scrap docks at Southern Pacific Shops in Sacramento.

billet furnaces and rerolled into raw stock for various classes of locomotive, car and track parts. This, of course, in addition to the immense amount of material reclaimed in its former character, such as bolts, nuts, washers, hose fittings, and a multitude of forged and other parts admitting of salvaging by the common processes of hammering, straightening, rethreading, grinding or treating otherwise by the usual shop methods.

A general view of the scrap docks at this plant is presented in Fig. 373. Figure 374 shows one of the platforms at the docks

with a large number of piles of small scrap stock made up into the form of billets for hauling to the rolling mills in the yard, where they will be manufactured into various sizes and sections of stock for use in a multitude of ways.

In sorting out scrap at these docks everything that admits of reclamation in the original form, such as bent and stripped bolts, washers, track spikes, oil box covers, and so on, are placed in piles by themselves and laid aside for reclamation at the shops on the scrap docks. With comparatively little work such material is classified and put into condition without being worked up

Fig. 374.—Scrap material made up into billets for re-working in the rolling mill.

as raw material for starting again through the manufacturing departments.

The general view, Fig. 375, illustrates two operations in the reclamation shops at the scrap docks. In the foreground is seen the retapping of nuts, while at the rear the stripping of old air hose is represented. Figures 376 and 377 illustrate respectively the process of sorting washers and the sharpening of old track spikes. These views represent but a small part of the work that is performed at this point. Nuts reclaimed here have run into the hundreds of thousands in a month's time. Hose couplings and the nipples may easily reach 10,000 or more a month and other parts come along in like proportions.

In sorting such parts as washers they are grouped by size on different pegs or wooden spindles which hold 50 to 100 each and

FIG. 375.—Re-threading nuts and stripping hose.

FIG. 376.—Sorting washers.

transferred directly from the pegs to bins in convenient racks.

Track spikes are reclaimed in endless quantities. Before they are sharpened as referred to in connection with Fig. 377, they are put through a straightening machine, which is in the form of an upright pneumatic hammer, the hammer die being carried by an air piston operated by the cylinder at the top of the structure. The lower die is fastened to the table or bed. The control of the piston is secured by foot action on the treadle on the floor.

One department handles in the way of reclamation, such tools as monkey wrenches needing repair, worn Stillson wrenches, gate

FIG. 377.—Sharpening track spikes.

valves, pipe fittings of all kinds, and miscellaneous items rounding up a total of considerable size and of wide diversity of character. A small blacksmith shop at the scrap docks takes care of many kinds of bent and twisted material of medium or light weight. A few classes of work so handled has run in the course of a month about as follows, this work including straightening and re-forming: 1,000 coupling pins; 150 car carry irons; 54 air cylinder levers; 1,500 brake shoe keys; 70 coupling levers; 54 car angle irons; 125 steel bottom carry irons; 500 small corner irons; 260 large irons; 150 door hangers; 25 door fulcrums; 125

FIG. 378.—Bolts of all kinds sorted for reclaiming.

FIG. 379.—Old oil-box covers to be straightened.

car levers; 2,000 oil-box corners; 200 tie plates; 5,000 grab irons; and other miscellaneous small forgings of various kinds weighing 2,300 lb.

In Fig. 378 is illustrated an enormous number of bolts and nuts of all kinds sorted out in piles for reclaiming. This is accomplished by cutting off the worn threaded ends, straightening the body, rethreading, and in the case of the nuts, retapping. The principle bolt shop is located in the main shops, and where large numbers of bolts are put through they are usually sent there for reclaiming.

Fig. 380.—Old shoes and wedges with babbitt to be melted out.

Figure 379 shows a pile of oil-box covers that come in large numbers to the scrap docks. In some cases these are sheet-metal stampings, in others they are malleable iron. In either instance they are reclaimed by heating, and straightening the flat covers, straightening out the hinge ends for the pins, closing the ends where they spring open, and so on, all of these operations being performed at the smith shop on the scrap dock.

Figure 380 represents a pile of old shoes and wedges on the reclamation docks where the brass is melted out and a saving of a large quantity of metal thus effected. The furnace for melting out the brass is seen to the left of the reclamation platform.

An interesting machine on the platform is the punch press in Fig. 381, which uses a gang of four punches for piercing four holes at one stroke in steel tie-plates. The dies carry a shear at the right, the stop is further to the right, and a stripper is placed across the center of the die block to clear the four round dies inserted in the die block.

FIG. 381.—A gang punch in tie plate holes.

OPERATIONS ON CAR BRASSES

One of the most important items of reclamation is car brasses which are overhauled in the babbitt shop in the main plant. Here all old brasses from the road come back for relining unless worn too thin for service or too short on the ends for further use. There is thus a considerable saving of old babbitt which is melted out of the brasses and a more important saving in the brasses themselves which under usual conditions will last for several years on the road. This babbitt shop relines as many as 3,000 old brasses in the course of a month, in addition to turning out 4,000 or 5,000 new brasses in the same length of time. Old babbitt recovered from worn brasses, from crossheads, etc., forms the bulk of the material required for pouring both old and new brasses. Enough new metal is added to the reclaimed babbitt to bring the material up to the analysis to which this lining metal is held.

A journal-bearing gage for testing brasses is used which takes care of five sizes of brasses. The gage proper is a cylindrical bar with sections which are used to check the diameter of the brass and the length from end to end. The gage proper is of cast iron, the casting being made with a bar across the end to allow a center to be drilled and countersunk therein for the turning of the casting in the lathe. The gage bar is mounted on two standards made up of flat stock 4 in. wide by ½ in. thick.

SAVING TIN IN ANTIFRICTION AND BELL METALS

The following data pertaining to the Pennsylvania Railroad practice in respect to tin saving in antifriction and bell metals are from a paper by H. M. Waring.

The necessity for conserving tin has recently been very forcefully brought to the attention of all consumers, and efforts are now being made to reduce the tin content in certain alloys or to substitute other alloys not containing tin.

The approximate composition of the nonferrous alloys in general use on the Pennsylvania Railroad are as follows:

	Copper	Tin	Lead	Phosphorus	Antimony	Zinc
Phosphor bronze, specification 32-C	79.70	10.00	9.50	0.80		
Extra bearing bronze, specification 141	76.75	8.00	15.00	0.25		
Car-journal bronze (*a*)	(*b*)	(*c*)	(*d*)	(*e*)	....	(*f*)
Special high-lead bronze, specification 59	70.00	5.00	25.00			
Lining metal, specification 57	....	....	87.00	....	13.00	
Dandelion metal	....	10.00	72.00	....	18.00	
Bell metal	83⅓	16⅔				
Babbitt, tin base	3.70	88.90	....	....	7.40	
Babbitt for motor bearings	1.00	50.00	38.50	....	10.50	

(*a*) Sum of Cu, Pb, Sn and Zn, not less than 99.
(*b*) Sum of Cu, Pb, Sn and Zn, not less than 71.
(*c*) Sum of Cu, Pb, Sn and Zn, not less than 4.
(*d*) Sum of Cu, Pb, Sn and Zn, not less than 13.
(*e*) Sum of Cu, Pb, Sn and Zn, not more than 20.
(*f*) Sum of Cu, Pb, Sn and Zn, not more than 3.

Phosphor bronze is used principally for rod bushings, main-rod brasses, and crosshead shoes.

Extra bearing bronze is used to a small extent for backs of car and coach bearings, but most of these are now made of the car-journal bronze, which contains on the average about 5 per cent tin.

Car-journal bronze is used for making car and coach bearing backs at the Altoona brass foundry by melting down old backs after removing the linings and making the necessary addition of new metal to bring the composition within the limits given above. No new tin is added in making this alloy.

Special high-lead bronze is used principally for locomotive driving-box shells, which are not lined. The lead-base lining for car-journal bearings was formerly made up in our foundry from lining metal melted off from old bearings and brought up to specification requirements by the addition of such new metals as might be necessary. Some tin was unavoidably introduced from the old bearings, but the amount allowed in the metal was limited to 2 per cent. Lately we have been using this old lining metal in the preparation of the lead-base dandelion-metal babbitt, thus making use of the contained tin in order to reduce the amount of new tin which it was necessary to add to this metal. The journal-lining metal is then made from lead and antimony without the addition of any tin.

Lead-base dandelion-metal babbitt, containing about 10 per cent tin, is used for lining crosshead shoes and also for lining engine, truck and trailer bearings, as well as for hub liners, in place of phosphor bronze on freight locomotives. This metal has replaced a large amount of tin and tin-base babbitt formerly used.

Tin-base babbitt metal (88.9 tin, 3.7 copper, 7.4 antimony) is used for a number of purposes in the shops, but its use has been greatly restricted, and every effort is being made to do away with it where possible, and to substitute a lead-base babbitt or a babbitt with 50 per cent tin.

The amount of solder having the composition 50 lead, 50 tin, used by the Pennsylvania Lines East during 1917, was approximately 100,000 lb., but there is reason to believe that a large portion of this can be replaced by a 60-lead, 40-tin solder with satisfactory results, and instructions have been issued to this effect.

No change has been made in the specifications for bearing metals for some years, as the metals used have been satisfactory A large proportion of the bearing metals are made up from old material remelted and brought to standard composition by some addition of new metal, and every effort is being made to utilize old material to the best advantage and reduce the amount of new metal of all kinds purchased. For a number of years no tin has been used in the lining metal of either passenger or freight-car journal bearings except such small amounts as come in from remelting old linings. No change has been made in phosphor bronze used for rod bushings, as we should expect some trouble from bushings pounding out of shape if a phosphor bronze were used which contained less tin or more lead than the present specifications call for. In this as well as in the case of all other bearing metals we expect to use our utmost endeavors to economize and to substitute for tin wherever possible.

CHAPTER XXIII

HANDLING MATERIALS IN THE RAILROAD PLANT

The value of special appliances for handling semifinished and finished parts around the shop is generally recognized, and one of the most important features of many plants today is the equipment provided for just this purpose. Not only is material thus taken care of to good advantage without loss or injury, but, furthermore, there is a marked gain in economy of time and effort upon the part of the force. Also, heavy work may be done without danger to the workmen when suitable apparatus is in use for picking up and moving parts about the shop floors.

A few illustrations of equipment for handling railroad-shop work are herewith presented. These views up to Fig. 389 are reproduced from photographs taken in the Southern Pacific shops, Sacramento.

In Fig. 382 is shown a method of piling axles with the aid of special hooks, which enable the men to roll the axles along from one tier to another without difficulty and with no liability of injury to hands or feet. These parts, weighing several hundred pounds, are usually more or less troublesome to stack up into piles where an ordinary bar is used, but the hooked bars shown take care of the job easily and safely. The end of the bar is formed into an S-shape, the outer end of which drops over an axle journal while the upper curve of the S fits under the journal of the axle that is to be lifted. With two hooks, one axle after another can be lifted up and rolled over the curved ends of the hooks into the tier above the one it originally occupied.

Another handy axle appliance is shown by Fig. 383, it being a combination of axle tongs and a truck. The truck is fitted with a steel cradle for receiving the axle, and when the end of the work is lifted by the tongs the truck is easily backed under it. The tongs are so made that when the axle is grasped between the jaws the handles form a straight line, and the axle can be picked up with the tongs held as rigid and straight as a single bar of metal.

Fig. 382.—Hooked bars for piling axles.

Fig. 383.—Tongs for handling axles from pile and track.

A coupler truck is shown by Fig. 384. It is a two-wheeled vehicle with the axle raised at the middle to receive a horizontal tube clamped to the top of the axle. Links are fastened to the horizontal bar at front and rear, and in these are held rings for the short chains by which the coupler is suspended. The longitudinal position of the supporting bar for the coupler is such that the work is nicely balanced and can therefore be lifted from the floor with little effort. The looped handle at the end of the truck is proportioned for convenience in operating.

FIG. 384.—A coupler truck.

Another truck is illustrated in Fig. 385. It is used for handling air tanks for locomotives and for supporting them while they are being secured to the engine. The truck frame is of steel angles, light but sufficiently strong. Across the top are two flat plates carrying nuts fitting on 2-in. square-thread screws. The nuts are provided with handles like pilot-wheel spokes, these being operated to adjust the long elevating screws by which the tank is lifted to the height required for the locomotive. The tops of the elevating screws are fitted with arc-shaped cradles of a radius to accommodate the diameter of the tank, and of a length of arc equal to about one-fourth of a circle.

Another truck built along somewhat similar lines is seen in Fig. 386. This one is for handling draft rigging. It is neces-

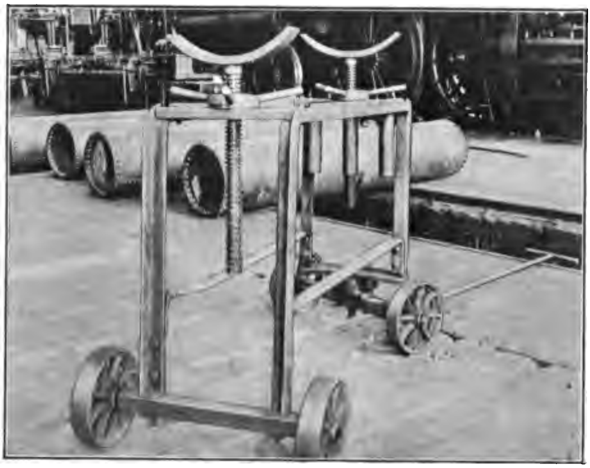


FIG. 385.—A tank supporting truck.

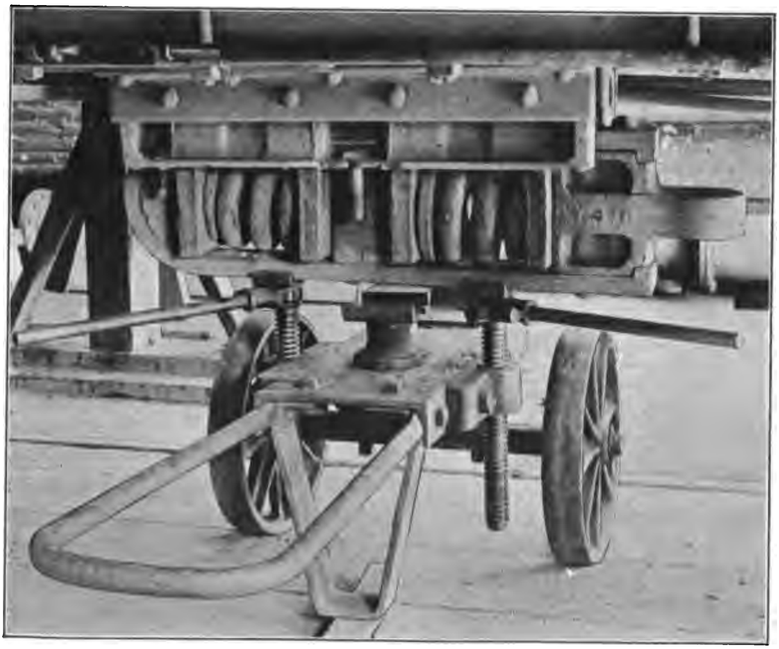


FIG. 386.—Draft rigging truck.

sarily made with a low body and it combines with the truck features a double lifting jack both for forcing the draft rigging up into place and for holding it while it is being fastened permanently in position. The truck carries at the center of the body a supporting shoe or cradle to receive the work, and the elevating screws are similarly fitted with channelled shoes to suit the lower leg of the yoke. To elevate the screws, each is provided with a ratchet head and a long operating handle, so that the draft rigging

FIG. 387.—Spring clamping device.
Old method at the left. New method at the right.

can be quickly and rigidly jacked up into place as soon as the truck has been backed into position.

In Fig. 387 two methods are illustrated for applying spring-clamping devices. At the left is shown the old way, at the right the new method. The advantages over the old method as regards both convenience and safety are well brought out upon comparison of the two illustrations. With the newer method, instead of lifting the spring from the top, the jack and its slings

are carried beneath, the truck with the jack being run back directly under the job where there is no opportunity for the work to drop. The device is very compact and as readily handled

Fig. 388.—A ladle truck for the foundry.

Fig. 389.—Car used for carrying work into soda pit for washing.

about the shop as an ordinary truck, since it is practically self contained.

One more form of truck is shown in Fig. 388, which illustrates a device for handling ladles filled with molten metal about the foundry. The ladle is carried in a strong ring at the end of a long handle which passes through a bracket on the truck. The support from the truck axle is by means of four coiled springs which are heavy enough to carry the weight imposed upon them, but which also insure easy riding of the ladle and enable the apparatus to be run along the floor without shock and without danger of the metal being spilled when moving from flask to flask.

The handling of materials in and out of soda tanks for washing is another important operation in railroad shops, and a good illustration of a safe and convenient method for immersing large numbers of parts at one is shown by Fig. 389. The car will be seen on the incline just above the level of the liquid. The tank and approach are safeguarded by heavy hand rails.

EQUIPMENT USED IN OTHER SHOPS

The views in the following engravings are from various shops showing different methods of handling miscellaneous material.

Fig. 390.—Another axle truck.

The truck in Fig. 390 is made especially for picking up and moving about the shop such parts as axles, shafts of one kind or another and other members of similar character. In the form illustrated the truck is fitted with a long steel handle made in one piece with an extension at the rear of the axle for suspending a pair of tong-shaped jaws that correspond in dimensions with a similar pair of jaws hanging at the front of the axle. The proportions of these jaws are such as to admit shafts or axles of practically any size used about the plant, and work of any length

may be moved with facility. The handle, it should be noticed, is sufficiently long to enable ample leverage to be applied for readily lifting heavy work from the floor; and the balancing of long lengths is of course made possible by the liberal center distance between the suspending jaws, the construction of which is clearly shown in the illustration. These carts have proved to be convenient for handling axles.

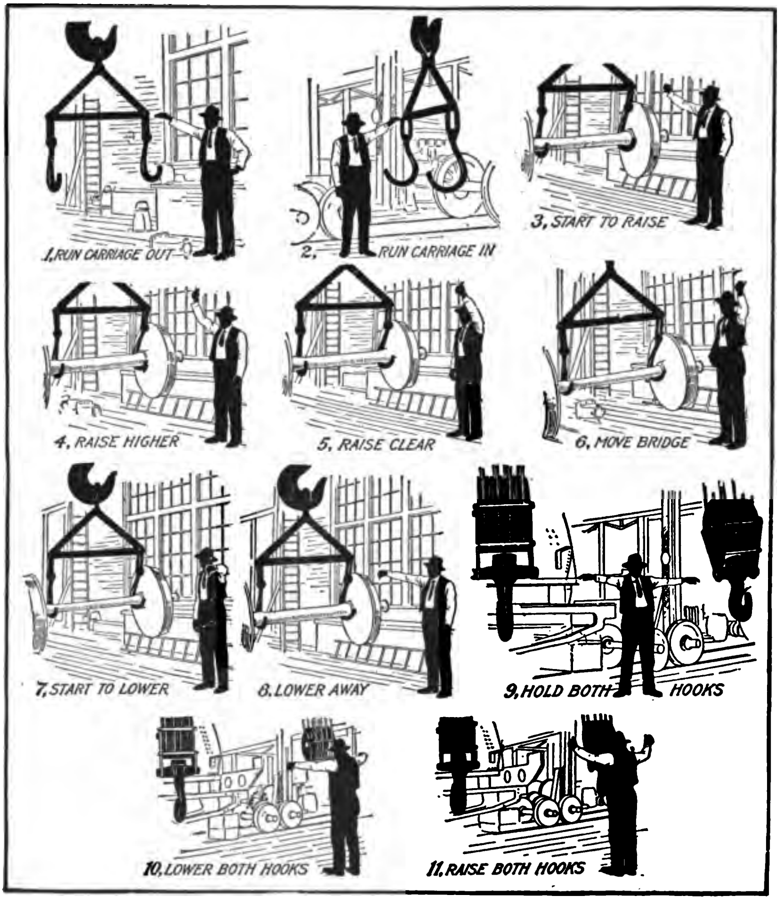


Fig. 391.—Crane signals.

A CRANE SIGNAL SYSTEM

The engravings under the general group, Fig. 391, show the system of signals used for controlling the operations of the cranes in the railroad shops at Sparks, Nev.

In No. 1 the position of the hand and arm indicates that the crane hook and sling are to be moved ahead, or directly away from the man, while in No. 2 the hooks are to be run back over the truck wheels. In No. 3 the wheels are shown picked up, the signals in both No. 3 and 4 being to raise the load.

Number 5 is the signal to raise still higher, and No. 6 to move the wheels laterally, or toward the shop wall to bring them directly over the rails. Numbers 7 and 8 are the lowering signals, with the arm extended horizontally and the thumb of either hand turned downward.

The signals in Nos. 9, 10 and 11 are for controlling simultaneously both hoists of the main crane. The outwardly extended arms with hands outstretched, as in No. 9, give the signal to hold the hooks in the position shown. With both hands turned downward, as in No. 10, the signal to the crane operator is to lower both hooks simultaneously. In No. 11 the arms bent upward and thumbs raised indicate that both hooks are to be elevated in unison.

INDEX

R

S